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SPACECRAFT 002
LITTLE JOE II LAUNCH VEHICLE
PERFORMANCE AND INTERFACE
SPECIFICATION
(U)

22 October 1965

Contract NAS9-150

Exhibit I, Para. 4.1

Approved by

Dale D. Myers

Dale D. Myers
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Program Manager - Apollo

[redacted]

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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ILLUSTRATIONS

*To be determined

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TABLES

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SPACECRAFT 002
LITTLE JOE II LAUNCH VEHICLE
PERFORMANCE AND INTERFACE SPECIFICATION

1.0 SCOPE

1.1 General. - This specification defines the performance and interface requirements for Spacecraft 002 (SC-002) and the Little Joe II Launch Vehicle 12-51-3, (LJ II), including the associated Ground Support Equipment (GSE) and Government Furnished Equipment (GFE). SC 002 and LJ II shall be utilized together with a Launch Escape System (LES) to perform a planned abort mission at the White Sands Missile Range (WSMR), New Mexico. The general configuration of the SC-002 and LJ II launch vehicle is shown in Figure 1.

1.2 Objective. - The specific objective of the launch phase abort mission shall be the demonstration of the capability to abort in the critical power-on tumbling boundary region. This region is defined by abort initiation at which the combined aerodynamic and launch escape motor exhaust pressures of tumbling abort imposed on the Command Module (CM) surface affect a pressure differential across the CM outside structure that approaches the design limit range of 9.0 to 11.1 psi.

The CM and LES shall separate from the Service Module (SM) and LJ II during initial launch ascent. During the ascent, the LJ II pitch control motor shall provide a pitch-up thrust causing the LES-CM to tumble end-over-end along the launch trajectory. The canard surfaces of the LES shall subsequently be deployed to arrest the tumbling motion and orient the CM aft heat shield leading downward. The LES shall separate from the CM jettisoning the tower and CM boost protective cover. The Earth Landing Subsystem (ELS) parachutes shall be deployed to affect a safe descent and touchdown of the CM.

2.0 APPLICABLE DOCUMENTS

The following documents, of exact issue shown, form a part of this specification to the extent specified herein:

[redacted]

[redacted]

2.1 Project Documents. -

SPECIFICATIONS

Military

MIL-E-6051C 17 June 1960	Electrical Electronic System Compatibility and Interface Control Requirements for Aeronautical Weapons Systems, Associated Subsystems and Aircraft

National Aeronautics and Space Administration (NASA)

MSC-GSE-1B 23 June 1964	Apollo Ground Support Equipment-General Environment Criteria and Test Specification.
MSC-ASPO-C3C 19 November 1964	Crimping of Electrical Connectors, Requirements for.
MSFC-PROC-158A 12 April 1962	Soldering Electrical Connectors (High Reliability) Procedure for (as amended by MSC-ASPO-5C dated 25 November 1964).

North American Aviation, Inc., /Space and Information Systems Division (NAA/S&ID)

SID 63-313 Revised 22 February 1965	CSM Technical Specification Block I
SID 64-1237 Revised 22 February 1965	CSM Master End Item Specification - Block I
SID 65-699 Revised 22 February 1965	CSM 002 End Item Specification, Part I, Performance/Design Requirements Apollo
MC 999-0002B 3 January 1963	Electromagnetic Interference Control for the Apollo Space System

General Dynamics - Convair (GDC)

(To be determined)

STANDARDS

[redacted]

Military

MIL-STD-130B 24 September 1962	Identification Marking of U.S. Military Property
MS53586A 16 December 1958	Metals, Definition of Dissimilar

OTHER PUBLICATIONS

U.S. Standard Atmosphere 1962

ARDC Model Atmosphere 1959

IRIG 104-60 Time Format Standards

2.1.1 Reference Documents. - The following documents, shall be used for reference only and are not to be construed as an integral part of this specification.

National Aeronautics and Space Administration (NASA)

NASA-SM-1 January 1964	NASA-MSC/WSMR Safety Manual

North American Aviation, Inc., Space and Information Systems Division (NAA/S&ID)

SID 64-2174 29 January 1965	Vehicle Test Plan, Apollo Mission A-004, Spacecraft 002
SID 63-502 1 December 1964	Apollo Measurement Requirements, Spacecraft 002
SID 65-1028 20 September 1965	Predicted Preflight Actual Weight and Balance Report for CSM 002.
MA 020 100 71 12 March 1965	Integrated System Checkout Procedure for Spacecraft 002 and 010

General Dynamics - Convair Inc. (GDC)

GDC 64-236A February 1965	Little Joe II Launch Vehicle Description Manual
GDC 63-073 April 1963	Checkout Manual, Little Joe II Launch Vehicles

2.2 Precedence. - The order of precedence in the instance of conflicting requirements shall be as follows:

[redacted]

North American Aviation, Inc., Space and Information Systems Division (NAA/S&ID)

a. The Contract, NAS9-150

b. SID 63-313, CSM Technical Specification - Block I

c. This Specification

d. SID 65-699, CSM 002, End Item Specification, Part I, Performance/Design Requirements, Apollo

f. Other Documents referenced herein

General Dynamics/Convair (GDC)

a. The Contract NAS9-492

b. GDC (TBD)*

c. This Specification

d. Other Documents referenced herein

3.0 REQUIREMENTS

3.1 Performance. - The following are the collection of principles to which the basic technical approach of the launch vehicle subsystems must be responsive. They are the first order criteria from which successive design criteria, performance margins, tolerance, and environments shall be developed.

3.1.1 Operational Requirements. - Apollo Mission A-004 shall be a planned abort mission in the power-on tumbling boundary region. This region is defined by abort initiation at which the combined aerodynamic and launch escape motor exhaust pressures of tumbling abort imposed on the CM surface affect a pressure differential across the CM outside structure that approaches the design limit range of 9.0 to 11.1 psi. SC 002 shall be launched by the booster to approximately 58,700 feet, at which point the abort shall be initiated. A pitch-up shall be performed by the booster just before abort initiation to ensure the LES tumbling during the abort. An apogee of approximately 73,000 feet will be reached. Tumbling of the LES structure and the CM will continue up through the apogee and down through the upper region of descent until orientation and stabilization are accomplished by the canards. Deceleration for vehicle touchdown and recovery

*To be determined

19 miles from the point of launch shall be accomplished by the earth landing subsystem (ELS). The nominal mission performance profile is delineated in Figure 2.

3.1.1.1 Little Joe II Launch Vehicle. - LJ II first stage, consisting of two Algol solid propellant rocket motors and five Recruit solid propellant rocket motors, shall provide a nominal thrust of 376,900 pounds for the first 1.5 seconds and a nominal thrust of 204,600 pounds for the remainder of the first stage burn and throughout the second stage burn. The second stage shall consist of the two remaining Algol motors which shall be ignited 37 seconds after launch. Four fins and associated hydraulically actuated elevon control surfaces shall provide the primary mode of vehicle stability and attitude control as shown in Figure 3. A dual timer unit shall be onboard the LJ II for providing the 2.8 second delay from pitch-up initiation to LEV abort initiation. The nominal thrust-time curve for the Algol rocket motors is shown in Figure 4. The thrust-time for the Recruit motors is shown in Figure 5.

3.1.1.2 Launch Escape Subsystem. - The LES for SC 002 shall include the structural tower secured onto and over the apex of the CM and supporting the LES tubular casing including the following components:

Boost Protective Cover (BPC)

Q-ball instrumentation package

Pitch control motor

Jettison motor

Escape motor

Canard airfoils

Ballast

The LES and pitch control motors shall initiate separation of the LEV (LES and CM) from the LJ II. Eleven seconds after abort initiation and while ascending to apogee, the canard airfoils will be deployed to effect vehicle orientation and stabilization. Actual LEV control shall be achieved subsequent to apogee and not later than descent through the 50,000-foot altitude region. The LES and BPC shall be jettisoned by the tower jettison motor. Four hundred milliseconds after LES and BPC jettison, thrusters will

[redacted]

jettison the forward heat shield. Thereafter the sequence of events to effect earth landing will be as described in 3.1.1.4. The LEV and LES and subsystems orientation with diagrams of the reference axis and subsystems are presented in Figures 6 and 7.

3.1.1.3 Flight Plan. - Mission A-004 power-on tumbling abort consists of the following flight sequences as shown in Figure 8.

a. SC 002-LJ II launch

b. Abort test point

c. LEV tumbling abort

d. Canard deployment and orientation

e. LES jettison and BPC separation

f. Parachute deployment and CM deceleration

g. CM earth touchdown

3.1.1.3.1 Launch. - The launch configuration, consisting of SC 002 and LJ II, shall nominally rest on the launcher at 84 degrees from downrange horizontal as described in Figure 9. Two of the four LJ II Algol motors and the five Recruit motors shall be ignited simultaneously for liftoff by land-line signal from the NASA Control Blockhouse. Burnout of the first stage shall nominally occur 43 seconds after liftoff. The remaining two Algol second stage motors shall nominally be ignited simultaneously 37 seconds after liftoff. The booster shall maintain the programmed trajectory to the abort point.

3.1.1.3.2 Abort Test Point. - The parameters of the power-on tumbling boundary abort envelope are defined as the point where the combined aerodynamic and launch escape motor exhaust pressures imposed on the CM surface approach the design limit range of 9 to 11.1 psi across the CM outer structure. The recommended abort initiation conditions superimposed on the nominal Apollo/Saturn V boost trajectory envelope is presented in Figure 10.

3.1.1.3.2.1 Abort Envelope. - Power-on tumbling boundary abort Mission A-004 may be accomplished, not only from the precise abort point but from any point within the designated envelope as shown in Figure 11.

3.1.1.3.2.2 Abort Initiation. - The following abort initiation provisions may apply:

[redacted]

[redacted]

a. The primary mode of abort initiation will be by redundant radio command to the LJ II signaling the pitch-up maneuver. The ground real-time display of vehicle altitude and velocity shall be monitored from the Control Station for the optimum instant and pitch-up maneuver to account for vehicle component dispersion. The LJ II abort timer shall be actuated upon start of the pitch maneuver and abort initiation shall occur 2.8 seconds after initiation and approximately 78 seconds after vehicle lift-off.

b. Backup initiation of the abort (without the pitch-up maneuver) will be provided by timing circuitry contained in the SC.

3.1.1.3.3 Launch Escape Vehicle Tumbling Abort. - Abort shall nominally occur at 62,500 feet altitude approximately 78 seconds after liftoff. Vehicle velocity shall be approximately Mach 2.45 and the dynamic pressure approximately 583 pounds per square foot at the abort point. Burnout of the two Algol second stage motors shall approximate the abort initiation maneuver. Escape shall be accomplished by firing the launch escape motor, propelling the LEV on an upward escape course beyond the LJ II trajectory, LEV instability, brought about by a change in the angle-of-attack (LJ II pitch maneuver) and a shift in the center of aerodynamic pressure on the LEV through escape motor exhaust plume envelopment, will nominally tumble the LEV throughout its trajectory. Burn time of the launch escape motor shall be approximately seven seconds. The LEV shall continue its tumbling course on a coast-up after escape motor burnout to an apogee of approximately 73,000 feet.

3.1.1.3.4 Canard Deployment and LEV Orientation. - The canard surfaces shall deploy eleven seconds after abort initiation on coast-up. At 50,000 feet and below, LEV tumbling shall be arrested by the canards, stabilizing and orienting the CM with the aft (main) heat shield in the direction of descent.

3.1.1.3.5 Launch Escape Subsystem and Boost Protective Cover Jettison. - At approximately 24,000 feet altitude the LES and BPC shall be jettisoned as one unit by LES jettison motor firing. The CM forward heat shield will be ejected by thruster firing 400 milliseconds after LES and BPC jettison. The thruster will be mechanized to jettison the heat shield 0.4 second after signal for the LES jettison motor to avoid collision of the jettisoning components.

3.1.1.3.6 Parachute Deployment and Command Module Deceleration. - Two (2) seconds after LES jettison, two drogue parachutes shall be deployed at 40 percent reefed configuration to minimize opening shock loads. Disreefing to the nominal parachute diameter will occur 8 seconds after line

[redacted]

stretch. As the CM drops through 11,000 feet, the drogues will be released. Simultaneously, pilot parachutes will be deployed by mortars. Pilot chutes will extract the main parachutes in a 9 percent reefed configuration. The main chutes will be disreefed 8 seconds, after line stretch. CM touchdown shall occur approximately 375.0 seconds after lift-off at approximately 19 miles from the LC 36.

3.1.1.4 Sequence of Mission Events. - The nominal sequence of the A-004 mission events with associated flight parameter values is contained in Table I. The mission sequencer subsystem block diagram interface and flow path of each event is delineated as shown in Figure 12.

3.1.1.4.1 Operational Timelines. - The operational timeline history for the A-004 mission is presented in Figure 13. Included are timelines for mission events and information transmission and recording equipment duty cycles.

3.1.1.5 Data Acquisition Subsystem Requirements. - The methodology utilized to acquire test vehicle instrumentation data and interface is delineated in SID 63-502, Apollo Measurement Requirements for information. The following subsystems shall provide operational flight data:

3.1.1.5.1 Onboard Tape Recorders. - Two onboard recorders, shall be provided to record telemeter outputs and measurements requiring high-frequency response. The tape transports shall operate at 15 inches per second (minimum) and will be capable of providing approximately 10 minutes of recording time.

3.1.1.5.2 Telemeter and Antenna Subsystems. - A telemeter subsystem utilizing a PAM FM/FM subsystem shall be provided. Each transmitter has a power output of approximately 5 watts. There will be no in-flight calibration. The required timing and accuracy, as well as format, shall be compatible with type-B code system (IRIG 104-60, Time Format Standards).

3.1.1.5.3 C-Band Transponders. - Two C-band transponders receiving at 5480 mc and transmitting at 5700 mc shall be provided. Each transponder shall operate independently and shall be power-divided into two cavity antennas. The C-band radar transponders shall respond to incoming pulse code signals and reply to WSMR tracking stations. Reply signals shall have a pulse rate frequency (PRF) that shall be a function of the interrogation rate of the WSMR tracking stations.

[redacted]

3.1.1.5.4 Camera Installation. - One camera shall be installed in the LEV. The camera shall be mounted in the launch escape tower along the centerline to permit photographic coverage of the BPC and observation of the launch escape tower from the CM. The configuration of the camera installation is described in Figure 14.

3.1.1.6 Instrumentation. - The complete list of SC 002 measurements are contained in SID 63-502 for information.

3.1.2 Operability.

3.1.2.1 Reliability. - To be determined.

3.1.2.2 Maintainability.

3.1.2.2.1 Maintenance. - Equipment arrangements, accessibility, and interchangeability features that allow efficient preflight servicing and maintenance shall be given full consideration. Design considerations shall also include efficient mission scrub and recycle procedures.

3.1.2.2.2 Maintenance Concept. - Field maintenance of SC 002-LJ II subsystems shall be performed as follows:

a. For airframe electrical/electronic equipment (either installed or on the bench), checkout and replacement shall be at the integral package (black box) level. A "black box" is defined as a combination of factory replaceable units which are contained within a physical package, and which is removable from the SCM 002-LJII as an integral unit.

b. For non-electrical/electronic equipment (either installed or on the bench), checkout and replacement shall be at the lowest replaceable serialized unit level, which includes only those parts which are removable as integral units from the CSM 002-LJII.

Bench test equipment may be used for malfunction verification of packages (units) removed from the CSM 002-LJII because of suspected failure. The malfunctioned package (unit) shall be returned to the supplier. Bench test equipment may also be used for spares certification before installation.

3.1.2.3 Useful Life. - SC 002 modules, LJ-II and internal subsystems shall not be designed for reuse after recovery.

[redacted]

[redacted]

3.1.2.4 Natural Environment. - These requirements define the natural environmental criteria to which the CSM 002-LJII equipment and associated Ground Support Equipment (GSE) shall be designed.

3.1.2.4.1 CSM 002-LJII and GSE Ground Environments

3.1.2.4.1.1 Transportation, Ground Handling, and Storage. - The following represent the natural environmental extremes which may be encountered by CSM 002-LJII equipment and GSE in a nonoperating condition during transportation, ground handling and storage. Exposed GSE shall be capable of operating during exposure to these environments. Other GSE and CSM 002-LJII equipment may be protected by suitable packaging for transportation and storage if these environments exceed the equipment design operation requirements. The equipment shall be capable of meeting the operating requirements of the applicable performance specification after exposure while protected by its normal packaging, to these environments.

a. Temperature (air)

Air transportation	-45 to +140 F for 8 hours
Ground transportation	-20 to +145 F for 2 weeks
Storage	+25 to +105 F for 3 years

b. Pressure

Air transportation	Minimum of 3.47 psia for 8 hours (35,000 ft altitude)

c. Humidity	0 to 100 percent relative humidity, including conditions wherein condensation takes place in the form of water or frost for at least 30 days.
d. Sunshine	Solar radiation of 360 Btu square foot per hour for 6 hours per day for 2 weeks.
e. Rain	Up to 0.6 inch per hour for 12 hours, 2.5 inches per hour for 1 hour.

[redacted]

f.	Sand and dust	As encountered in desert and ocean beach areas, equivalent to 140-mesh silica flour with particle velocity up 500 feet per minute and a particle density of 0.25 grams per cubic foot.
g.	Fungus	Materials will not be used which will support or be damaged by fungi.
h.	Salt spray	Salt atmosphere as encountered in coastal areas, the effect of which is simulated by exposure to a 5% salt solution by weight for 48 hours.
i.	Ozone	3 years exposure, including 72 hours at 0.5 ppm, 3 months at 0.25 ppm and the remainder at 0.05 ppm concentration.
j.	Hail	Hailstones accumulating to a maximum depth of 2.0 inches on horizontal surfaces in 15 minutes having an average diameter of 0.31 inches, a density of 50 lb/ft^3 and a hardness of 3 on the Mott scale. Impact velocity shall be based on a fall rate of 100 ft/sec maximum with a minimum wind speed of 33 ft/sec maximum.
k.	Groundwinds	These ground wind criteria consist of a description of WSMR wind data for the height intervals of 10 to 400 feet.

(1) Free standing. - Wind speeds for structural loading considerations of the CSM 002-LJII stack at WSMR are presented in the table below. Wind speeds occurring during the strongest wind month at WSMR, New Mexico, are less than those present 99.9 percent of the time.

[redacted]

Height (ft)	Steady State Wind (knots)	Peak Wind (knots)(*)
10	23.0	32.2
30	28.7	40.2
60	32.0	46.1
100	36.5	51.1
200	41.9	58.7
300	45.4	63.6
400	48.1	67.3

*Gust Characteristics: For the effects of gusts, a linear buildup from the steady state winds to the peak winds will be assumed. The period of this buildup and decay shall be taken as 4 seconds for all height levels; that is, buildup of 2 seconds and 2 seconds for decay to steady state wind speed.

3.1.2.4.1.2 Sheltered Environment Areas. - These requirements represent the natural environmental design criteria for SC 002-LJII equipment and GSE both in operating and non-operating conditions as determined by normal operational flow sequences. The equipment shall be capable of meeting the operating requirements of the applicable performance specification during and after exposure to these environments. The level of environmental control at each Apollo site shall be as indicated in MSC-GSE-1.

3.1.2.4.1.2.1 Interior Uncontrolled. - An environment in which the temperature, sand, salt spray, etc., are only partially controlled.

a. Temperature — +15 to +105 F for up to 3 years

b. Humidity — Zero to 100 percent relative humidity including conditions wherein condensation takes place in the form of water or frost for at least 30 days.

c. Sunshine — Solar radiation at 360 Btu per square foot per hour for 6 hours per day for 2 weeks.

[redacted]

d. Sand and dust	As encountered in desert and ocean beach areas, equivalent to 140-mesh silica flour with particle velocity up 500 feet per minute and a density of 0.25 grams per cubic foot.

3.1.2.4.1.2.2 Other Environment Areas. - Natural environments to which certain GSE are exposed, such as the launch umbilical tower, shall be as indicated in MSC-GSE-1.

3.1.2.4.2 Flight Environments. - These requirements represent the natural environmental design criteria for the SC 002-LJII equipment in an operating condition as experienced during the flight mission phase. The exposure time for the mission phase environment shall be as presented below, unless otherwise defined in this section:

Mission Phase	Duration (Seconds)
Ascent to Test Point (Separation of LEV from LJII)	T + 78
Test Point to Apogee	T + 103
Descent to Touchdown	T + 375

The equipment shall be capable of meeting the operating requirements of the applicable performance specification during and after exposure to these environments.

3.1.2.4.2.1 Ascent Phase. -

a. Reference Atmosphere	For aerodynamic heating estimates above 98,430 feet (30 kilometers), the reference atmosphere shall be ARDC 1956.
b. Ground winds	The design wind speed for launch of SC 002-LJII is presented in the table below. Wind speed occurring during the strongest wind month at WSMR are less than those presented 95.0 percent of the time.

[redacted]

Height (ft)	Steady State Wind (knots)	Peak Wind (knots)*
10	14.0	19.6
30	17.4	24.4
60	20.0	28.0
100	22.2	31.1
200	25.5	35.7
300	27.6	38.6
400	29.3	41.0
500	30.6	42.8

*Gust Characteristics: For the effects of gusts, a linear buildup from the steady state winds to the peak winds will be assumed. The period of this buildup shall be taken as 4 seconds for all height levels; that is, buildup of 2 seconds and 2 seconds for decay to steady state wind speed.

c. Winds aloft - The design of CSM 002-LJII shall consider flight through synthetic wind profiles constructed using the following criteria:

(1) Idealized Wind Profile Envelope: The 88 percentile idealized scaler wind speed profile envelope (quasi-steady-state) for WSMR is presented in Figure 15. These winds are to be applied without regard to direction.

(2) Wind Speed Changes (Wind Shear): Wind speed changes for altitude differentials up to 5000 meters are presented in Figure 16, constructing synthetic wind profiles in the altitude regions of peak profile speed.

(3) Gusts: Discrete quasi-square wave gusts shall be superimposed on the wind speed change such that the maximum wind speed does not exceed the idealized wind speed profile envelope, as shown in Figure 17. The gust speed shall be 9 meters/second.

(4) Profiles Without Gusts: For synthetic profiles not incorporating the quasi-square wave gust, the peak profile speed may be maintained for various altitude thicknesses before decay is begun. Figure 18 presents the allowable range of peak wind thicknesses.

[redacted]

3.1.2.4.2.2 Entry Phase. -

a. Reference atmosphere	The reference Earth atmosphere for primary and contingency landing sites shall be in accordance with U.S. Standard Atmosphere, 1962. For aerodynamic heating estimates, the reference atmosphere shall be ARDC 1959.

3.1.2.4.2.3 Descent Phase. -

a. Reference atmosphere	The reference Earth atmosphere for primary and contingency landing sites shall be in accordance with U.S. Standard Atmosphere, 1962. For aerodynamic heating estimates, the reference atmosphere shall be ARDC 1959.

3.1.2.4.2.4 Earth Impact. - These conditions shall apply at the WSMR Earth impact point.

Wind velocity	23.7 knots
Soils (static bearing strength and slope)	(TBD)*
Loose sand	6000 lb/ft^2 15 degrees max
Hard sand	25,000 lb/ft^2 5 degrees max

3.1.2.4.3 Command Module Post Landing Environments. - The requirements represent the natural environmental design criteria for CM equipment. This equipment shall be capable of meeting the operating requirements of the applicable performance specification for 48 hours during exposure to these environments.

a. Temperature

Air	85 degrees F maximum up to 48 hours
b. Altitude	4,036 ft

* To be determined

[redacted]

[redacted]

c. Humidity	85 percent relative humidity maximum at 85 degrees F air temperature, up to 48 hours.
d. Solar radiation	306 BTU/ft^2-hr maximum for 4 hours, followed by a linear decrease to zero BTU/ft^2-hr in 5 hours. Zero BTU/ft^2-hr for 10 hours, followed by a linear increase to 306 BTU/ft^2-hr maximum in 5 hours.
e. Rain	Up to 0.6 inch per hour for 12 hours, 2.5 inches per hour for 1 hour.

3.1.2.5 Transportability. -

3.1.2.5.1 Ground Handling and Transportability. - Full design recognition shall be given to the durability requirements of SC 002 and LJ II equipment and subsystems during preflight preparation. Wherever possible, equipment and modules shall be designed to be transported by common carrier with a minimum of protection. Special packaging and transportation methods shall be as required to prevent system penalties.

3.1.2.6 Human Performance. - Not applicable.

3.1.2.7 Safety. -

3.1.2.7.1 Hazard Proofing. - The design of the SC 002 and LJ II subsystems and support equipment shall minimize the hazard of fire, explosion and toxicity to launch area personnel and facilities.

3.1.2.7.2 Equipment. - Where practicable, the various components shall be hermetically sealed or of explosion-proof construction. The rocket motor igniter cartridges shall be capable of withstanding an electrical impulse of 1 ampere or 1 watt dc for 5 minutes without detonating.

3.1.2.7.3 Fail Safe. - Subsystem or component failure shall not propagate sequentially; that is, design shall be "fail safe."

3.1.2.8 Induced Environment. - These requirements define the induced environmental criteria to which the SC 002-LJII equipment and associated GSE shall be designed.

3.1.2.8.1 Spacecraft 002-Little Joe II Launch Vehicle Ground Support Equipment Ground Environments. -

[redacted]

3.1.2.8.1.1 Transportation, Ground Handling, and Storage. - The following represent the induced environmental extremes which may be encountered by SC 002-LJIILV equipment and GSE in a non-operating condition during transportation, ground handling and storage. Handling GSE shall be capable of operating during exposure to the environments. Other GSE and SC 002-LJII equipment may be protected by suitable packaging for transportation and storage if these environments exceed the equipment design operation requirements. The equipment shall be capable of meeting the operating requirements of the applicable performance specification after exposure while protected by its normal packaging, to these environments.

a. Shock

(1) Packaging - The design shock levels applicable to protective packaging, or directly to equipment when packaging is not used, shall be those resulting from free fall drops as presented in the table below. The protective packaging shall attenuate shock such that packaged SC 002-LJII equipment and GSE will not be exposed to shock levels exceeding the equipment design operating requirements.

		Drop Height		
Weight*	Dimensions** not exceeding	Free Fall	Edgewise	Cornerwise
Less than 50 pounds	36 inches	30 inches		
50 to 100 pounds	48 inches	21 inches		
100 to 150 pounds	60 inches	18 inches		
150 to 200 pounds	60 inches	16 inches		
200 to 600 pounds	72 inches		36 inches	36 inches
over 600 pounds	Over 72 inches		24 inches	24 inches

*Weight of equipment and package or containers (if used)
**Dimensions along any edge or diameter.

(2) Equipment - The design shock levels applicable directly to SC 002-LJII equipment and GSE, which utilize protective packaging, for which no other design operating requirements are established, shall be as presented in the following table:

[redacted]

Weight (pounds)**	Shock Level* (g)	Time (milliseconds)
Less than 250	30	11 ± 1 (half-sine waveform)
250 to 500	24	11 ± 1 (half-sine waveform)
500 to 1,000	21	11 ± 1 (half-sine waveform)
Over 1,000	18	11 ± 1 (half-sine waveform)

*As experienced in any direction.
**Weight of equipment and package or containers (if any).

b. Vibration - Sinoidal as experienced in any direction

Weight (pounds)**	5 to 26.5 cps	26.5 to 52 cps (inch DA)	52 to 500 cps
Less than 50	±1.56 g	0.043	±6.0 g
50 to 300	±1.30 g	0.036	±5.0 g
300 to 1,000	±1.30 g	0.036	
Over 1,000	±1.04 g	0.029	

**NOTE: Weight of equipment and package or containers, if any.

3.1.2.8.1.2 Sheltered environment areas. - These requirements represent the induced environmental design criteria for SC 002-LJ II equipment and GSE both in operating and non-operating conditions as determined by normal operational flow sequences. The equipment shall be capable of meeting the operating requirements of the applicable performance specification during and after exposure to these environments. The level of environmental control at each Apollo site shall be as indicated in MSC-GSE-1.

3.1.2.8.1.2.1 Interior controlled. - An environment in which the temperature, humidity, sand, salt spray, etc., are controlled.

a. Temperature — +60 to +80 for up to 3 years. +52 to +105 F for 1 hour maximum with environmental equipment out of commission

[redacted]

[redacted]

b. Vibration - Sinoidal as experienced in any direction

Weight (pounds)**	5 to 26.5 cps	26.5 to 52 cps (inch DA)	52 to 500 cps
Less than 50	±1.56 g	0.043	±6.0 g
50 to 300	±1.30 g	0.036	±5.0 g
300 to 1,000	±1.30 g	0.036	
Over 1,000	±1.04 g	0.029	

**NOTE: Weight of equipment and package or containers, if any.

c. Humidity — 30 to 70 percent for up to 3 years.

d. Sand and Dust

(1) Site — Particle count not to exceed Level 300,000 of Federal Standard 209. No more than 2,000 particles per cubic foot larger than 5 microns. No more than 35 of these larger than 65 microns. No more than 3 of these 35 particles larger than 100 microns.

(2) Fluid Systems — The following conditions apply to SC 002 LJ II closed and open fluid systems activity: Particle count not to exceed Level 100,000 of Federal Standard 209: No more than 700 particles per cubic foot larger than 5 microns. No more than 35 of these larger than 20 microns.

3.1.2.8.1.2.2 Other environmental areas. - Environments to which certain GSE are exposed, such as the environmental chamber, shall be as indicated in MSC-GSE-1.

3.1.2.8.2 Flight Environments. - These requirements represent the induced environmental design criteria for the SC 002-LJ II equipment in an operating condition as experienced during the various flight mission phases. The exposure time for each mission phase environment shall be as defined in 3.1.2.4.2 unless otherwise defined in this section. The equipment shall be capable of meeting the operating requirements of the applicable performance specification during and after exposure to these environments.

[redacted]

The following are induced environment which are present for all mission phases.

Temperature	The contractor shall provide temperature requirements for structure, subsystem, and component design for each applicable mission phase.

3.1.2.8.2.1 <u>Ascent Phase.</u> -

a.	Temperature	The following condition applies to the CM interior atmosphere: 55 F increasing to 90 F maximum.
b.	Vibration	Mechanical vibration from all sources of excitation as experienced by SC 022-LJ II structure. The design vibration levels for various zones of SC 002 are presented in Figures 19 through 23.
c.	Acoustics	Acoustic noise resulting from ground reflection and aerodynamic turbulence. The design acoustics levels for various zones of the LES and CM are presented in Figures 19 and 22 through 28.
d.	Aerodynamic heating	The design shall utilize the trajectory shown in Figure 29 plus LES plume impingement where appropriate.

3.1.2.8.2.2 <u>Entry Phase.</u> -

a.	Temperature	The following condition applies to the CM interior atmosphere: 60 F increasing to 90 F.
b.	Vibration	The design vibration levels for the CM are presented in Figure 30.
c.	Acceleration	The design sustained acceleration level is 20 g.
d.	Acoustics	The design acoustic levels for various zones of the CM are presented in Figures 24 through 28, when uniformly reduced by 10 db.

[redacted]

3.1.2.8.2.3 Descent Phase. -

a. Temperature — The following condition applies to the CM interior atmosphere: 90 F increasing to 110 F maximum.

b. Shock — Terminal peak saw-tooth pulse of 78 g (peak amplitude) with total duration 10 to 15 milliseconds, including decay time no greater than 10 percent of the total duration. Figures 31 and 32 define the accelerations.

3.1.2.9 Range Safety. - Standard operating procedures will define safety measures to be observed during the handling of the rocket motors, installation of igniters, testing of ignition circuits, installation of destruct charges and associated circuitry, utilization of shorting plugs, and final arming of the rocket motors and other ordnance devices.

3.1.2.9.1 Standard Operating Procedures. - Standard operating procedures will be prepared by NASA.

3.1.2.9.2 Ordnance Safety. Ordnance handling, vehicle—test facility integrated circuitry, and trajectory dispersion limitations will be specified in the NASA—MSC/WSMR Safety Manual, NASA-SM-1 for information.

3.1.2.9.3 Range Safety Destruct Subsystem. - Range safety destruct units shall be mounted on the LJ II Algol motors and upon receipt of the destruct signed by RF Command shall destroy the integrity of the motor chambers. Ground test and airborne control of the range safety subsystem shall be initiated and activated only by direction of the WSMR Range Safety Officer.

3.2 Interface Requirements. -

3.2.1 Little Joe II Launch Vehicle Interface Requirements. - Propulsion increments involved in the boost phase of the mission shall be supplied by the GDC LJ II 12-51-3 launch vehicle. LJ II shall be designed compatible with the following interface requirements.

3.2.1.1 Payload Capability. - For Apollo Mission A-004 LJ II shall be capable of boosting the payload described in SID 65-1028 plus ballast as directed by NASA-MSC into the nominal trajectory shown in Figure 8.

[redacted]

3.2.1.2 Little Joe II Attitude Control. - The elevating slant and azimuth shall be maintained within ±2 degrees. The roll rate shall be less than 10 degrees per second.

3.2.1.3 Loads Criteria for Service Module and Little Joe II Interface. - The following maximum flight parameters shall not be exceeded on Apollo Mission A-004.

3.2.1.3.1 Trajectory. - Loads evaluated for maximum Q conditions shall not exceed those based on the trajectory shown in Figure 29 as applied to Apollo Mission A-004.

3.2.1.3.2 Test Vehicle Weight Distribution. - Weight and mass properties distributions for the SC 002-LJ II test vehicle structure as shown in Tables II, III, and IV.

3.2.1.3.3 Weight, Gravity, and Inertia Summary. - The mass properties data for SC 002-LJ II are shown in SID 65-1028. The CSM stack c.g. will be adjusted by placement of ballast to obtain a Y = Z = 0 ± 0.5 condition to satisfy LJ II Guidance subsystem requirements.

3.2.1.4 Vehicle Stiffness. -

3.2.1.4.1 Little Joe II Launch Vehicle Bending Stiffness. - Bending stiffness properties for the SC 002-LJ II shall be as described in Figure 33.

3.2.1.4.2 Spacecraft 002 Launch Escape Vehicle Stiffness. - Stiffness properties for the LEV shall be as described in Figure 34 through 39.

3.2.1.5 Limit Loads. - The limit loads, shears, and bending moments at Station 0 and the SM adapter - LJ II structural interface shall not exceed those shown in the following table for conditions of maximum $q\ \alpha$ 5,550 lb/ft^2-degrees; for flexible body α = 8.5 degrees.

Load Parameters

Interface	S Shear lbs x10^{-3}	P Axial Load lbs x10^{-3}	Moment M_A lbs x10^{-3}	Moment ΔM_Z in-lb x10^{-3}	Moment ΔM_Y in-lb x10^{-3}
LJII/SM	26.0	-115.5	6,590	428	90.4

[redacted]

[redacted]

M_A is the moment due to trajectory and trajectory dispersions. M_Z and M_Y are fixed direction moments due to physical design of the vehicle. (CG locations, asymmetry, etc.)

3.2.1.6 Spacecraft 002-Little Joe II Weight and Balance Interface. - Weight and c.g. conditions of SC 002-LJ II shall be as shown in SID 65-1028.

3.2.1.7 Mechanical Interface. -

3.2.1.7.1 Service Module Adapter. - Little Joe II Interface. - The SM-LJ II Adapter shall structurally and functionally adapt the SM to the launch vehicle. In the area of the interface the provisions in Appendix A shall apply for information.

3.2.1.8 Electrical Interface. -

3.2.1.8.1 Electrical Power Subsystem. - Six GFE silver oxide-zinc storage batteries comprise the onboard electrical power source for SC 002. Two batteries shall power the instrumentation through a GFE power control box. An additional two batteries will furnish power to the sequencer subsystem circuit, and a third pair of batteries shall service the pyrotechnic power source, as shown in Figure 40.

3.2.1.8.2 Power Interfaces. - Electrical interfaces between CSM and the LJ II launch vehicle shall be designed in such a manner that there will be no exchange of electrical power between SC 002 and LJ II.

3.2.1.9 Research and Development (R&D) Instrumentation. - The installation of GFE R&D Instrumentation or equipment shall be subject to negotiation between the NASA and the contractor.

3.2.2 Launch Facilities. -

3.2.2.1 Location. - SC 002-LJ II will be launched from LC 36 at WSMR shown in Figure 41. Range plotting, flight performance and data acquisition requirements shall be as delineated in 3.2.4.1 and 3.2.4.2.

3.2.2.2 Launch Umbilical Tower. - One launch umbilical tower shall supply prelaunch monitoring and control functions to SC 002 and LJ II. The general description of the tower shall be as shown in Figure 9 and Appendix A.

[redacted]

3.2.3 Flight Vehicle Launch Preparation (WSMR). - Preparation of SC 002 and LJ II at WSMR shall consist of two phases; (1) assembly of the SC 002 with the LJ II, and (2) checkout and countdown at the launch site. The test sequence, from receipt of the vehicle at WSMR to launch countdown, is shown in Figures 42 and 43.

3.2.3.1 Vehicle Assembly and Preparation. - SC 002, LJ II, and GSE shall be delivered to the Vehicle Assembly Building (VAB) for receiving inspection. Final weight and center of gravity determination shall be accomplished in the VAB. Weight and balance tests of the SM shall not be performed unless extensive configuration changes are directed by NASA. The LES shall be weighed in the horizontal position and the CM shall be weighed in the horizontal and vertical position. A vertical weight and balance shall then be performed on the LEV. Based on the center of gravity established from these final weight and balance tests, the thrust vector alignment index of the launch escape motor will be defined. Optical means shall be used to project this thrust vector to a point on the CM so that this alignment can be reaffirmed after stacking.

The SM shall be transported to the launch pad for mating upon completion of LJ II buildup. After alignment testing, the assembled CM and LES shall be demated and transported to LC 36 for mating operations with LJ II.

3.2.3.2 Flight Vehicle Launch Site Preparation. - SC 002 shall be mated to the SM and LJ II combination. A Launch Escape Tower (LET) thrust vector verification test shall be performed, and the BPC shall be installed. Vehicle-GSE cabling shall be accomplished. Calibration of the instrumentation subsystem shall be reverified to be at launch level through the pad facilities and the vehicle telemetry subsystem. Subsystem safety verification tests shall be conducted to ensure checkout equipment compatibility and to verify subsystem operations. An integrated systems test shall then be conducted to verify test vehicle readiness. This test shall be followed by a simulated countdown and a final integrated systems test.

3.2.3.3 Flight Readiness Review. - A flight readiness review meeting under the direction of the NASA shall be the final declaration that the vehicle is ready for launch countdown. The launch countdown shall be the concluding activity that verifies the flight vehicle has the ability to operate within its performance specification during flight.

3.2.3.4 Procedural Checkout. - The operational test procedures and checkout shall proceed as the NASA may direct.

3.2.3.4.1 Prelaunch Operations. - The final phase of checkout and launch shall be conducted from the blockhouse under the direction of NASA. The precount and countdown to launch shall proceed as shown in Figures 41 and 42. The countdown embodies the detailed checkout and verification of

[redacted]

flight readiness of the spacecraft and the boost vehicle. The NASA Test Director shall retain responsibility to initiate the start of the countdown, to conduct evaluation activities, and to control the countdown from initiation to the announcement of "clear to launch."

3.2.4 Range Support and Interface Requirements. - Range support requirements shall be identified and detailed by the NASA document "Program Requirements Document" (PRD) and SID 64-2174. The areas in which support shall be required are as follows:

Photographic coverage
Optical and camera tracking
Telemetry recording
Range and pad safety
Meteorological support
Radar tracking
Vehicle recovery

3.2.4.1 Range Instrumentation Support Systems Interface. - The WSMR GFE telemetry stations shall be provided to insure reception and recording of instrumentation data throughout the flight of Mission A-004 as follows:

3.2.4.1.1 External Data Requirements. - Tracking and support data requirements such as sampling rates, accuracies, and referencing of data are delineated in SID 64-329, Apollo CSM Ground Operation Requirements Plan, Spacecraft 002, for information and includes the following:

3.2.4.1.1.1 Radar Tracking Data. - Radar tracking data shall be required to provide azimuth, elevation, slant range, velocity, and acceleration from launch to touchdown. Two C-band transponders shall be provided by NAA/S&ID in the CM to facilitate tracking. Raw radar data, consisting of time, azimuth, elevation, and slant range of each of the three vehicle components (LES, CM and SM) will be processed by WSMR facilities into a Cartesian coordinate system using X, Y, and Z as space position axes. The origin of this system will be at the launch pad. The X axis shall be positive in the direction of the intended flight path (north), the Y axis shall be positive 90 degrees clockwise from the position X axis (east), and the Z axis shall be positive upward to form a left-handed orthogonal set.

3.2.4.1.1.2 Photographic Requirements. -

a. Sequential and Theodolite Tracking: Tracking shall be required throughout the flight from liftoff at pad elevation (4036 feet) to apogee (73,000 feet) to CM touchdown approximately 42 statute miles down range from LC-36. Cinetheodolite positioning shall be accurate to plus or minus 20 feet and plus and minus one degree.

[redacted]

b. Documentary Films. - Motion picture and still photography documentary record of all key events associated with the SC 002-LJ II flight test shall be required. Photographic coverage shall include transportation, preflight preparations and checkout, flight operations, and postflight activities and events.

3.2.4.2 Flight Data Acquisition Interface. -

3.2.4.2.1 Flight Telemetered Data. - The flight telemetry data shall be recorded by WSMR recording stations. The flight data shall also be recorded by the GFE telemetry trailer as a backup. Each range recording station shall produce three magnetic tapes, an original and two copies. Immediately after termination of the test, the original tape from each site shall be given to NASA, one copy shall be given to the NAA/S&ID and GDC representative, and the remaining copy shall be retained by WSMR.

3.2.4.2.2 Onboard Magnetic Tape. - Upon termination of the flight, the onboard magnetic tapes shall be delivered to the telemetry trailer. One master copy shall be made from each of the original onboard tapes. Three additional copies shall be made from each master copy. The original tapes and one copy shall be delivered to NASA: S&ID shall retain one copy at the field site; and the master and remaining copy shall be given to the contractor representative.

3.2.5 Ground Support Equipment Interface. - The post test verification and acceptance procedure applicable to the ground support equipment interface shall be referenced in NAA/S&ID Operational Checkout Procedure SC 002 and GDC 63-073, Checkout Manual, Little Joe II Launch Vehicle.

3.2.6 Logistics Interface Requirements. -

3.2.6.1 Maintenance. - Maintenance concepts established for the Apollo program shall be coordinated with GDC and joint maintenance requirements established. Interface coordination will be required between NAA/S&ID, GDC and NASA to provide parallel service of technicians, mechanics and laborers to modify, maintain, checkout, service and prepare equipment.

3.2.6.2 Support Manuals. - NAA/S&ID and GDC shall prepare and provide manuals to define, in detail, operating instructions as well as maintenance, checkout and test procedures up to and including interface responsibilities for SC 002 and LJ II.

3.2.6.3 Material (Spares) Support. - NAA/S&ID, GDC and NASA shall coordinate functions which shall be established to provide interface requirements data for spares.

3.3 Design and Construction. -

[redacted]

3.3.1 General Design Features. -

3.3.1.1 General Arrangement. - The general arrangement of SC 002-LJ II LV is shown in Figure 1.

3.3.1.2 Design Criteria. -

3.3.1.2.1 General Design Analysis Criteria. - Design and operational procedures shall be conducted in accordance with rational design principles to include but not be limited to the following:

3.3.1.2.1.1 Limit Conditions. - The design limit load envelope shall be established by superposition of rationally deduced critical loads for all flight modes. Load envelopes shall recognize the cumulative effects of additive type loads. No subsystem shall be designed incapable of functioning at limit load conditions.

3.3.1.2.1.1.1 Ultimate Factor. - The ultimate factor shall be 1.5 applied to limit loads. This factor may be reduced to 1.35 for special cases subject to rational analysis and negotiation with MSC, NASA. The following deviation shall apply: the ERS parachutes, inclusive of risers and end fittings shall be designed to an ultimate factor of safety of 1.35.

3.3.1.2.1.2 Performance Margins. - Rational margins shall be apportioned to subsystems and components such that the greatest overall design efficiency is achieved within SC 002-LJ II capabilities and implementation criteria constraints.

3.3.1.2.1.2.1 Multiple Failure. - The decision to design for single or multiple failures shall be based on the expected frequency of occurrence as it affects subsystem reliability and safety.

3.3.1.2.1.2.2 Design Margins. - All SC 002-LJ II LV subsystems shall be designed to zero or positive margins of safety.

3.3.1.2.1.2.3 Attitude Constraints. - Attitude control is not available to eliminate system constraints.

3.3.1.3 Weights. - CM and SM may be varied, as required, within limiting total CSM Control Weights shown in SID 65-1028.

[redacted]

3.3.2 Selection of Specifications and Standards. - Materials, parts, and processes shall be selected in the following order of preference, provided coverage is suitable:

a. Federal Specifications approved for use by the NASA

b. Military Specifications and Standards (MIL, JAN, or MS)

c. Other Governmental Specifications

d. Specifications released by nationally recognized Associations, Committees, and Technical Societies.

3.3.3 Materials, Parts, and Processes. - Materials, parts, and processes shall be selected with the following considerations:

a. Materials, parts, and processes shall be suitable for the purpose intended. Safety, performance, reliability, and maintainability of the item are of primary importance.

b. Except in those instances where their use is essential, critical materials shall not be used.

c. Where possible, materials and parts shall be of kind and quality widely available in supply channels.

d. When practicable, a choice among equally suitable materials and parts shall be provided.

e. Whenever possible, single source items shall be avoided.

f. When practicable, circuits shall be designed with a minimum of adjustable components.

3.3.3.1 Flammable Materials. - Materials that may support combustion or are capable of producing flammable gases (which in addition to other additives to the environment, may reach a flammable concentration) shall not be used in areas where the environment or conditions are such that combustion would take place.

3.3.3.2 Toxic Materials. - Unless specific written approval is obtained from the NASA, materials that produce toxic effects or noxious substances shall not be used.

3.3.3.3 Unstable Materials. - Materials that emit or deposit corrosive substances, induce corrosion, or produce electrical leakage paths within an assembly shall be avoided or protective measures incorporated.

[redacted]

[redacted]

3.3.4 Standard Materials, Parts, and Processes. - Where applicable, preferred parts lists shall be used. When an applicable specification provides more than one grade, characteristics, or tolerance of a part or material, the standard parts, materials, and processes of the lowest grades, broadest characteristics, and greatest tolerances shall be chosen. However, standard parts, materials, or processes of high grades, narrow characteristics, or small tolerances may be used when necessary to avoid delay in development or production, obvious waste of materials, or unnecessary use of production facilities. The requirements specified for the use of standard parts, materials, or processes shall not relieve the contractor of the responsibility to comply with all performance and other requirements specified in the contract.

The soldering of electrical connectors shall be in accordance with specification MSFC-PROC-158, as amended by MSC-ASPO-S-5.

3.3.4.1 Non Standard Parts, Materials, and Processes. - Non standard parts, materials, and processes may be used when necessary to facilitie the design of the particular equipment. However, when such nonstandard items are incorporated in the design, they shall be documented as required by the contract.

3.3.4.2 New Parts, Meterials, and Processes. - New parts, materials, or processes developed under the contract may be used, provided they are suitable for the purpose intended. Any new parts, materials, or processes used shall be documented as required by the contract.

3.3.5 Moisture and Fungus Resistance. - Fungus-inert materials shall be used to the greatest extent practicable. Fungus-nutrient materials may be used if properly treated to prevent fungus growth for a period of time, dependent upon their use. When used, fungus-nutrient materials shall be hermetically sealed or treated for fungus and shall not adversely affect equipment performance or service life.

3.3.6 Corrosion of Metal Parts. - All metals shall be of corrosive-resistant type or shall be suitably protected to resist corrosion during normal service life. Gold, silver, platinum, nickel, chromium, rhodium, palladium, titanium cobalt, corrosion-resistant steel, tin, lead-tin alloys, tin alloys, Alclad aluminum, or sufficiently thick platings of these metals may be used without additional protection or treatment.

3.3.6.1 Dissimilar Metals. - Unless suitably protected or coated to prevent electrolytic corrosion, dissimilar metals, as defined in Standard MS 33586, shall not be used in intimate contact.

3.3.6.2 Electrical Conductivity. - Materials used in electronics or electrical connections shall have such characteristics that, during specified environmental conditions, there shall be no adverse effect upon the conductivity of the connections.

[redacted]

[redacted]

3.3.7 Interchangeability and Replaceability. - Mechanical and electrical interchangeability shall exist between like assemblies, subassemblies, and replaceable parts of operating subsystems (electronic, electrical, etc.) regardless of the manufacturer or supplier. Nonoperating subsystems such as structure need not comply with this requirement. Interchangeability for substitution of such like assemblies, subassemblies, and replaceable parts may be effected without physical or electrical modifications to any part of the equipment or assemblies; including cabling, connectors, wiring, and mounting. However, adjustment of variable resistors and trimmer capacitors may be made.

In the design of the equipment, provisions shall be made for design tolerances sufficient to accommodate various sizes and characteristics of any one type of article such as tubes, resistors, and other components having the limiting dimensions and characteristics set forth in the specification for the particular component involved without departure from the specified performance. Where matched pairs are required, they shall be interchangeable and identified as a matched pair or set.

3.3.7.1 Identification and Traceability. - Apollo identification and traceability shall be in accordance with the contractor's approved quality control plans.

3.3.8 Workmanship. - Not applicable.

3.3.9 Electromagnetic Interference. - Each assembly shall be electromagnetically compatible with other assemblies in the system, other equipment in or near the LV, associated test and checkout equipment, and to the electromagnetic radiation of the operational environment. The subsystem shall not be a source of interference that could adversely affect the operation of other equipments or compromise its own operational capabilities. The system shall not be adversely affected by fields or voltages reaching it from external sources, such as improperly suppressed vehicle test and checkout equipment, nearby radio frequency sources in the operational environment and electrostatic potential.

3.3.9.1 Spacecraft 002. - SC 002 shall be designed in accordance with MC 999-0002.

3.3.9.2 Little Joe II and Ground Support Equipment Subsystem. - This subsystem shall be designed in accordance with Specification MIL-E-6051.

3.3.10 Identification and Marking. - All assemblies, components, and parts shall be marked for identification in accordance with Standard MIL-STD-130.

[redacted]

3.3.11 Storage. - Specific requirements for storage of the SC 002-LJ II are stated in 3.1.2.4.1.1.

3.3.12 Lubricants. - Lubricants and lubrication shall be compatible with the combined environments in which they are employed. Lubricant material and process specifications shall be formulated to prescribe materials and describe application methods.

3.3.13 Connectors. - Wherever practical, all electrical and mechanical connectors shall be so designed as to preclude the possibility of incorrect connection. Crimping for single electrical pin and socket connectors shall be in accordance with the requirements of Specification MSC-ASPO-C3.

3.3.14 Miniaturization. - Miniaturization shall be accomplished to the greatest extent practicable, commensurate with required functions and performance of the system. Miniaturization shall be achieved by use of the smallest possible parts and by compact arrangement of the parts in assemblies. Miniaturization shall not be achieved by means that would sacrifice the reliability or performance of the equipment.

3.3.15 Special Tools. - The functional components of SC 002-LJ II component attachments shall be designed so that the use of special tools for assembly, installation, and service shall be kept to a minimum.

4.0 QUALITY ASSURANCE. -

4.1 Quality Control. - Each contractor shall be responsible for assuring that the Quality Control provisions imposed by their respective contracts are applied to the interface requirements specified in Section 3 of this specification.

4.2 Reliability. - Each contractor shall be responsible to assure that the reliability provisions of their respective contracts are applied to their respective portions of the interface.

5.0 PREPARATION AND DELIVERY. -

Not applicable.

6.0 NOTES

APPENDIX A Interface Control Documents

[redacted]

APPENDIX A

INTERFACE CONTROL DOCUMENTS

ICD MH01-04013-414	Apollo Flight Mission A-004 Apollo Spacecraft 002 - Little Joe Launch Vehicle

[redacted]

[redacted]

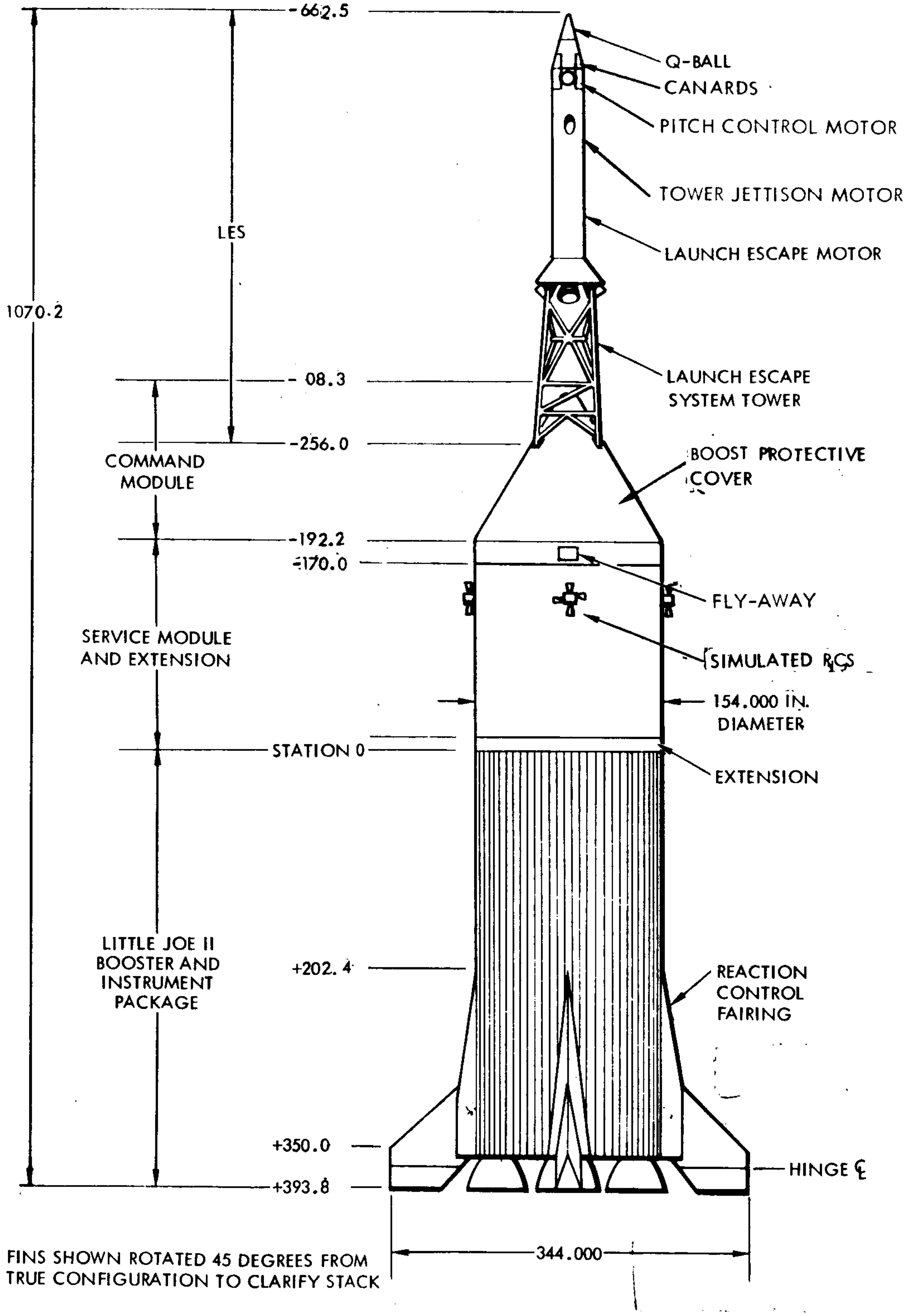


Figure 1. Spacecraft 002 Little Joe II Launch Vehicle

[redacted]

[redacted]

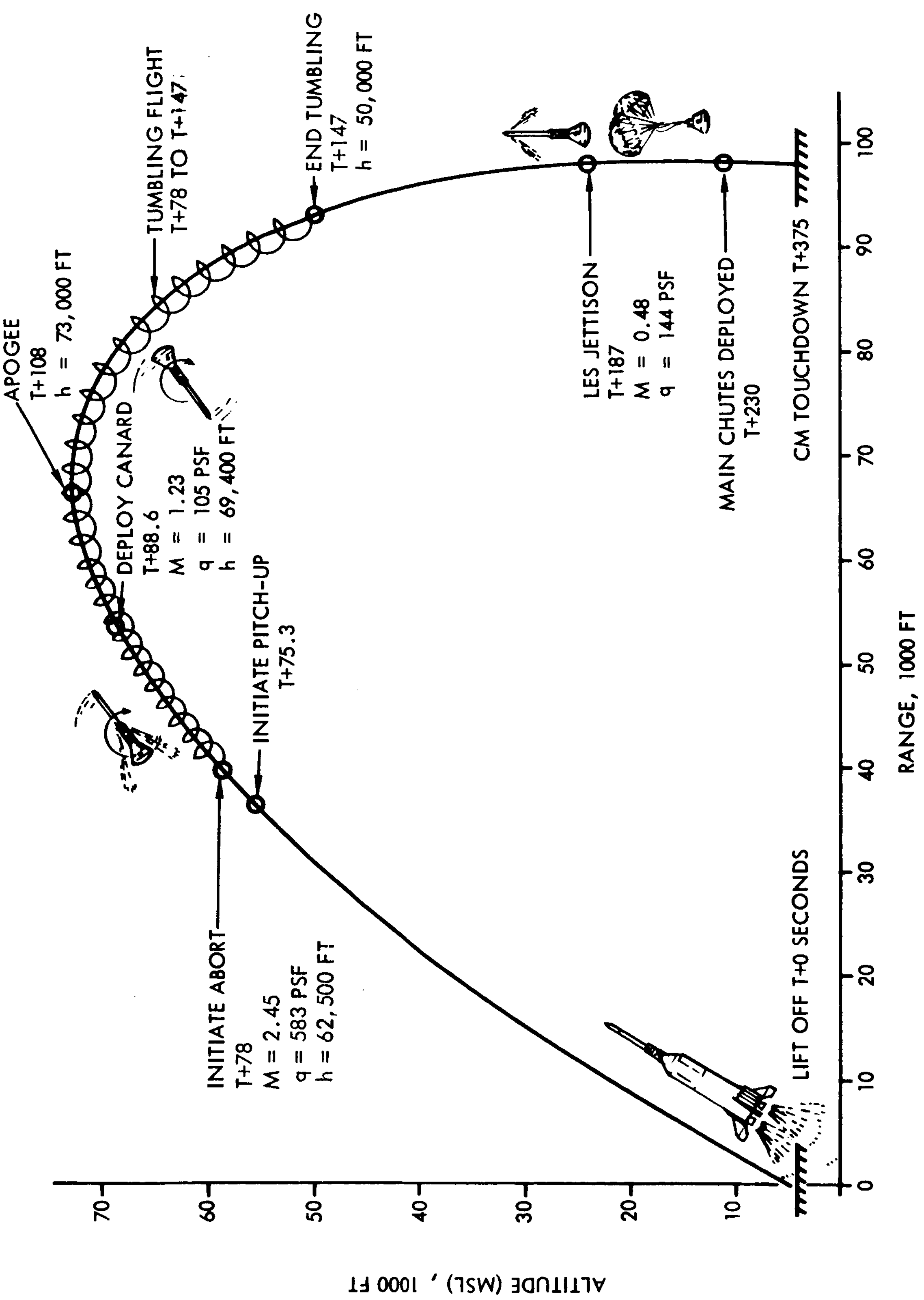


Figure 2. Spacecraft 002 Preliminary Mission Profile

[redacted]

[redacted]

(To be determined)

Figure 3. Little Joe II Launch Vehicle 12-51-3

[redacted]

[redacted]

PREDICTED ALCOL PERFORMANCE
APOLLO MISSION A-004
S/C 002 / LJ II 12-51-3
SEA LEVEL-ZERO NOZZLE ANGLE
AMBIENT TEMP 70F

-NOMINAL (AVERAGE THRUST OF LH-15, -16, -17, -18, AND -19 (SPARE)
PREDICTIONS BASED ON FIRINGS OF LJ-2, -5, AND -7.)
-MAX. (3 MOTORS)
-MIN. (3 MOTORS)

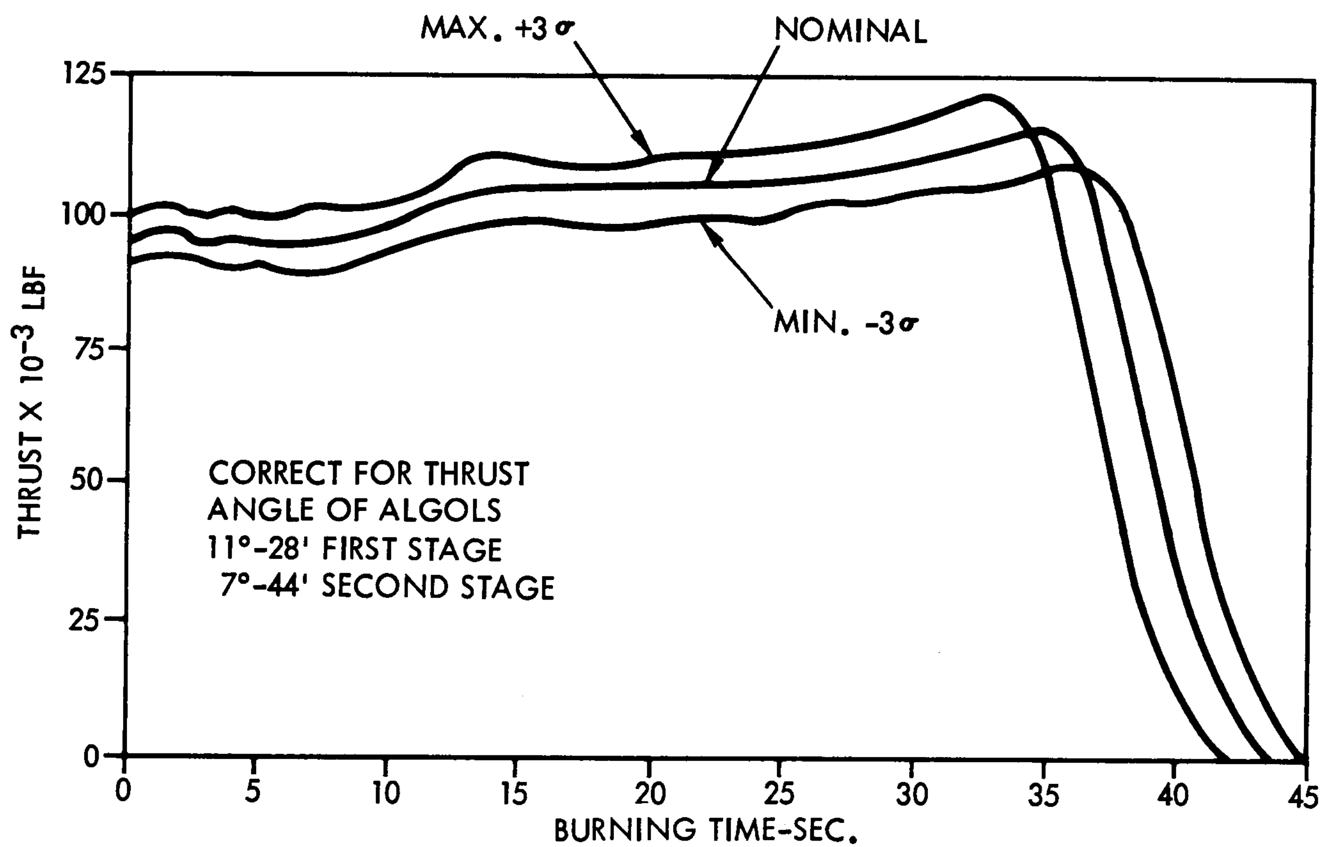
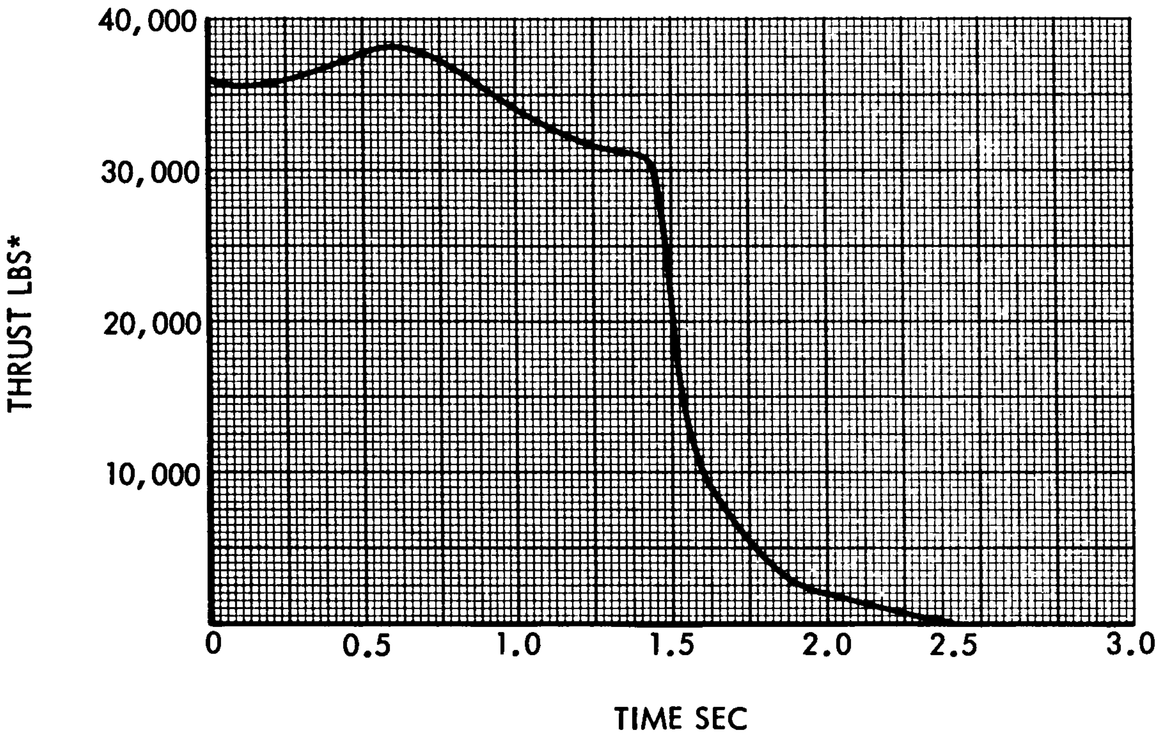


Figure 4. Nominal ALGOL Motor Thrust-Time Curve, Little Joe II Launch Vehicle

[redacted]

[redacted]



*THRUST AS SHOWN IS ACTING ALONG CENTERLINE AND MUST BE CORRECTED BY THE COSINE OF THE CANT ANGLE IN ORDER TO GIVE AXIAL THRUST

Figure 5. Single Recruit Thrust Time History

[redacted]

[redacted]

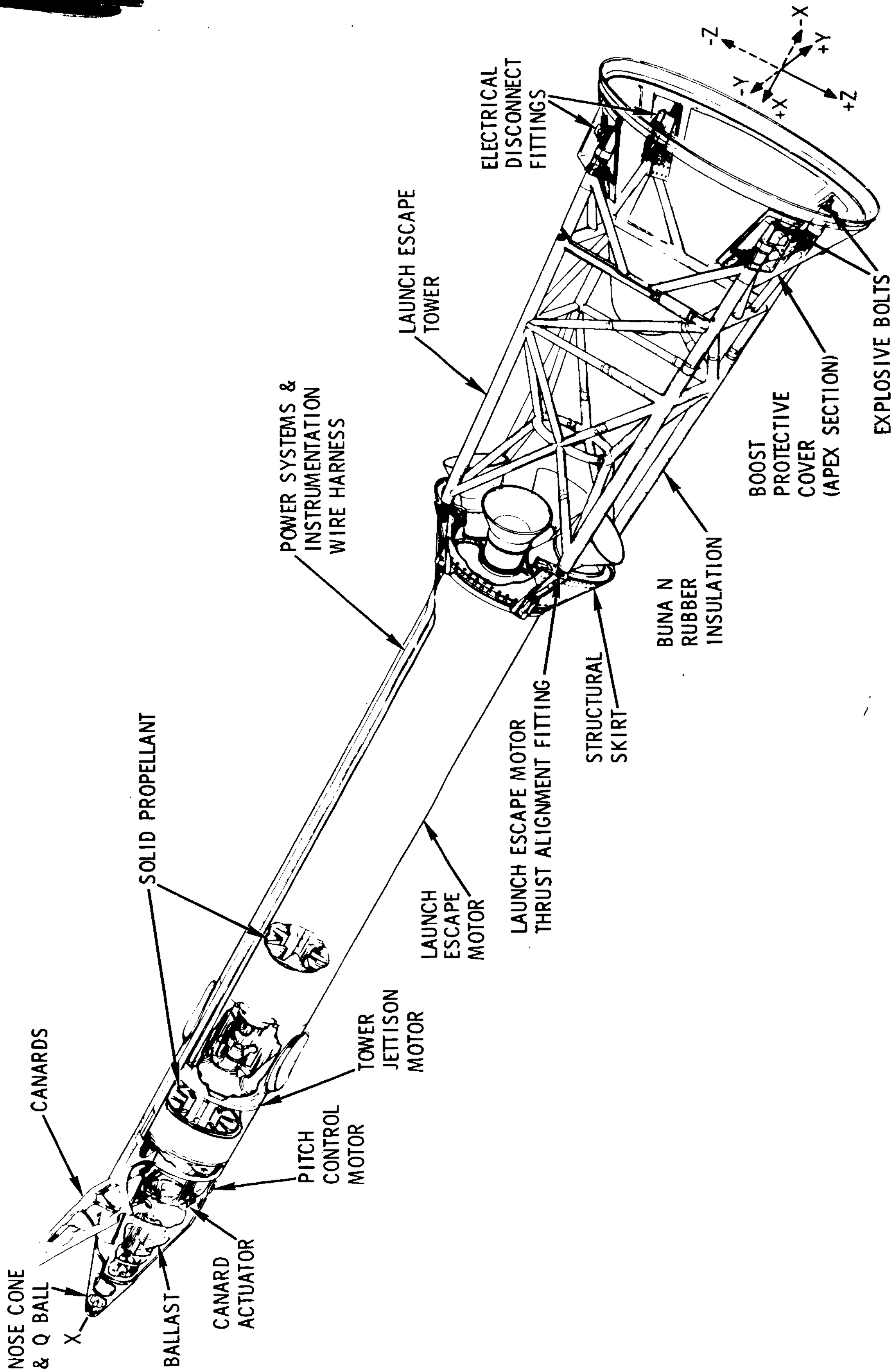


Figure 6. Launch Escape Subsystem Components

[redacted]

[redacted]

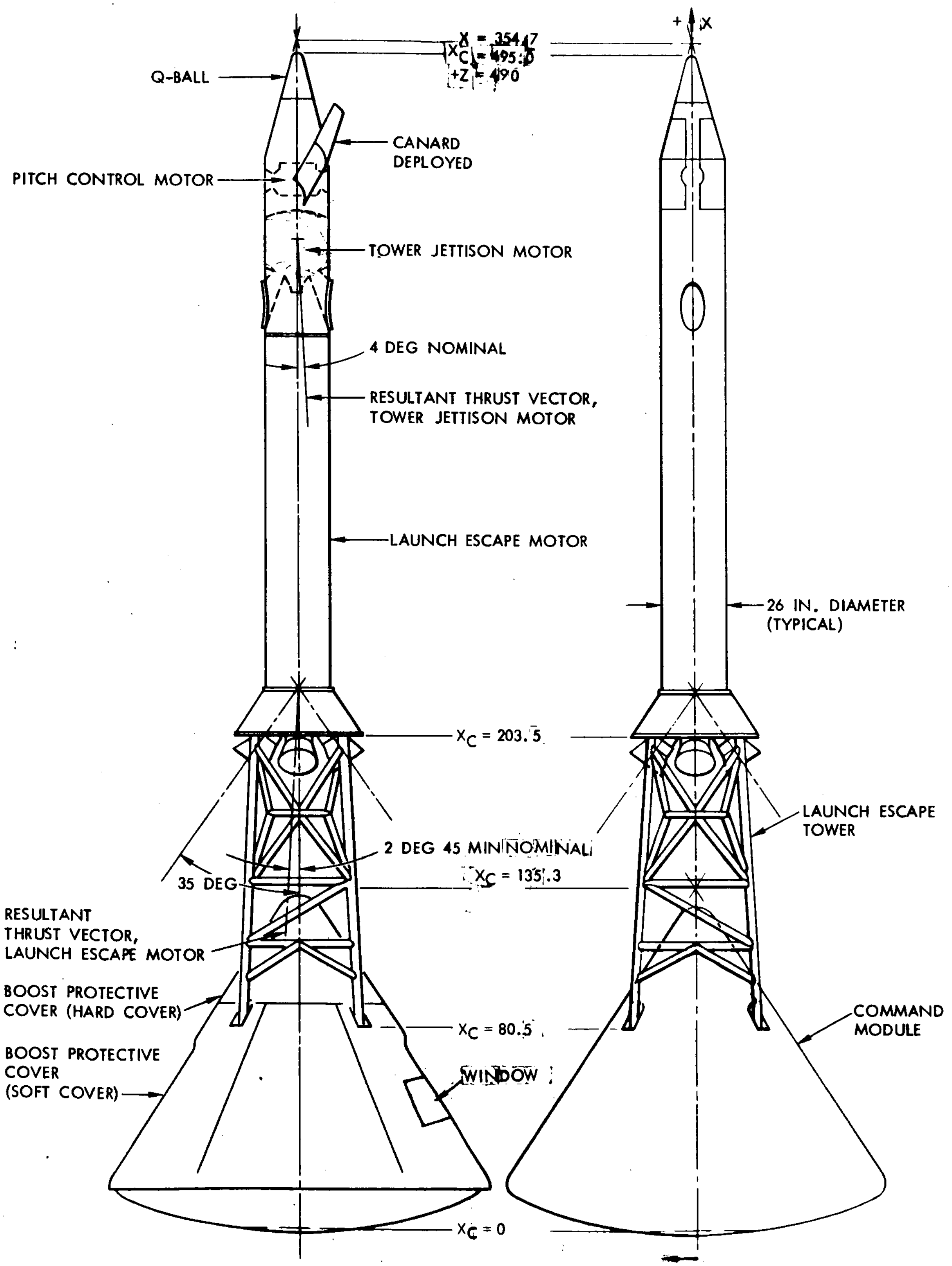


Figure 7. Launch Escape Vehicle Configuration

[redacted]

[redacted]

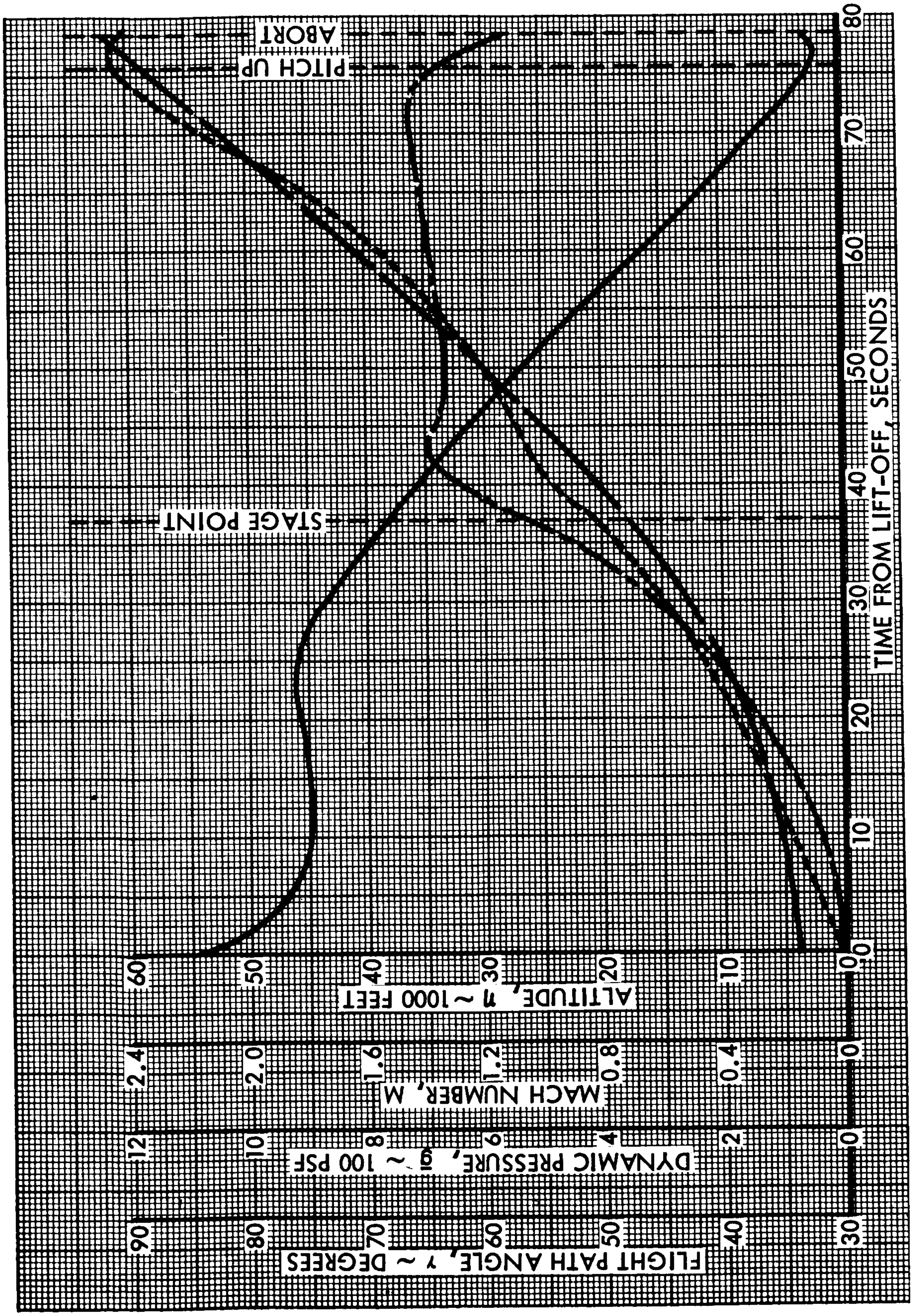


Figure 8. Spacecraft 002 Nominal Launch Trajectory

[redacted]

[redacted]

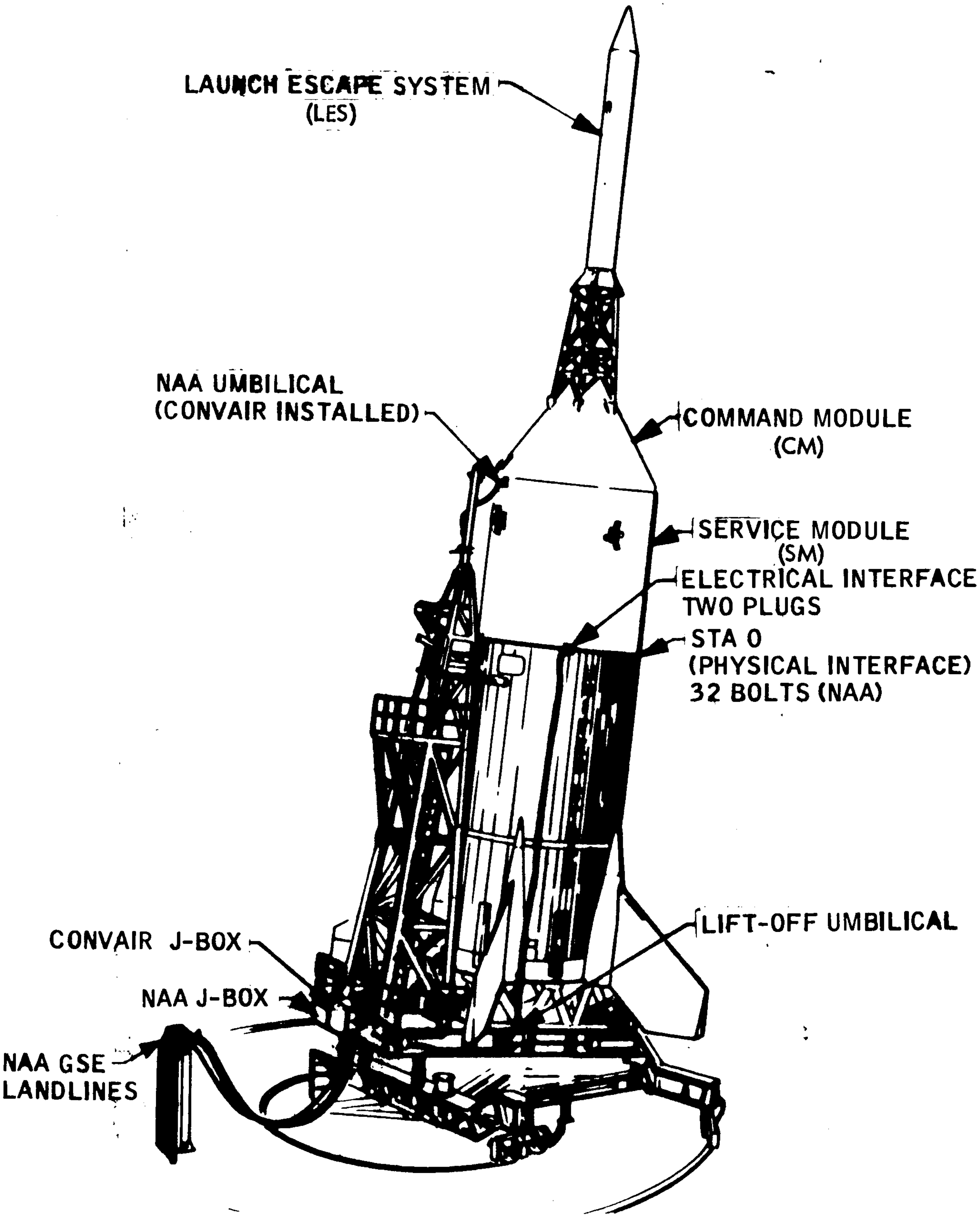


Figure 9. Spacecraft 002-LJII on NASA Launcher

[redacted]

[redacted]

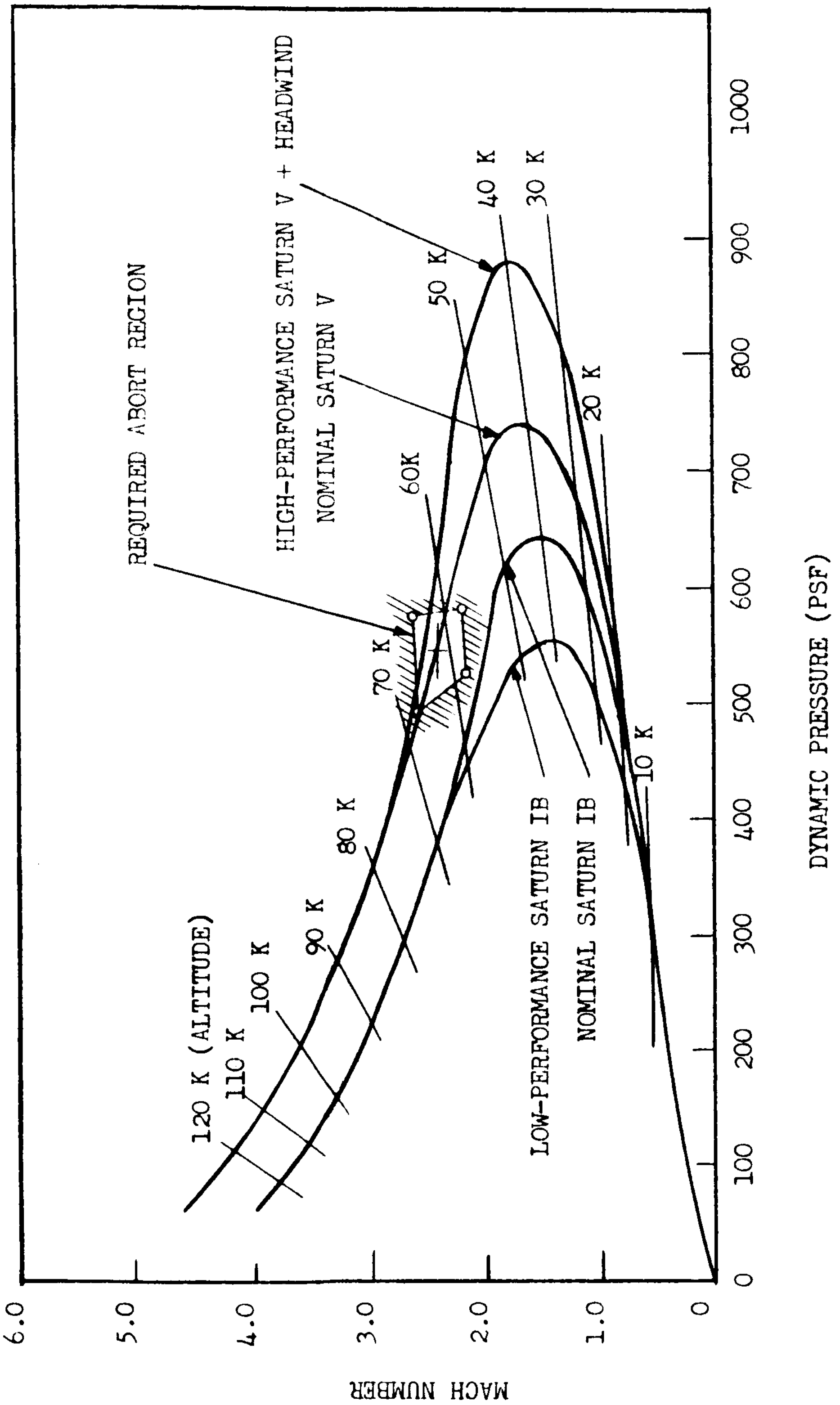


Figure 10. Saturn V Boost Trajectory Envelope

[redacted]

[redacted]

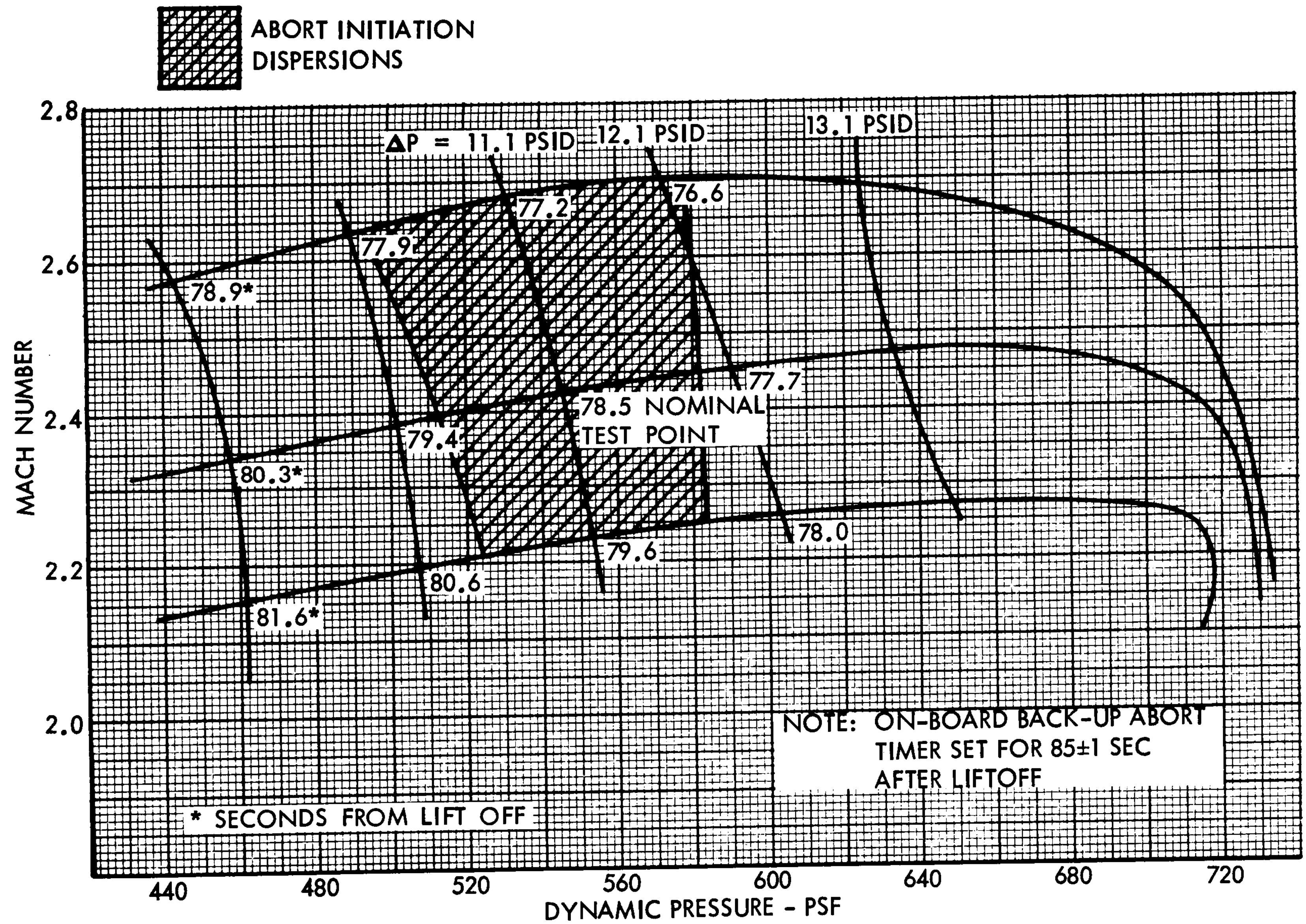
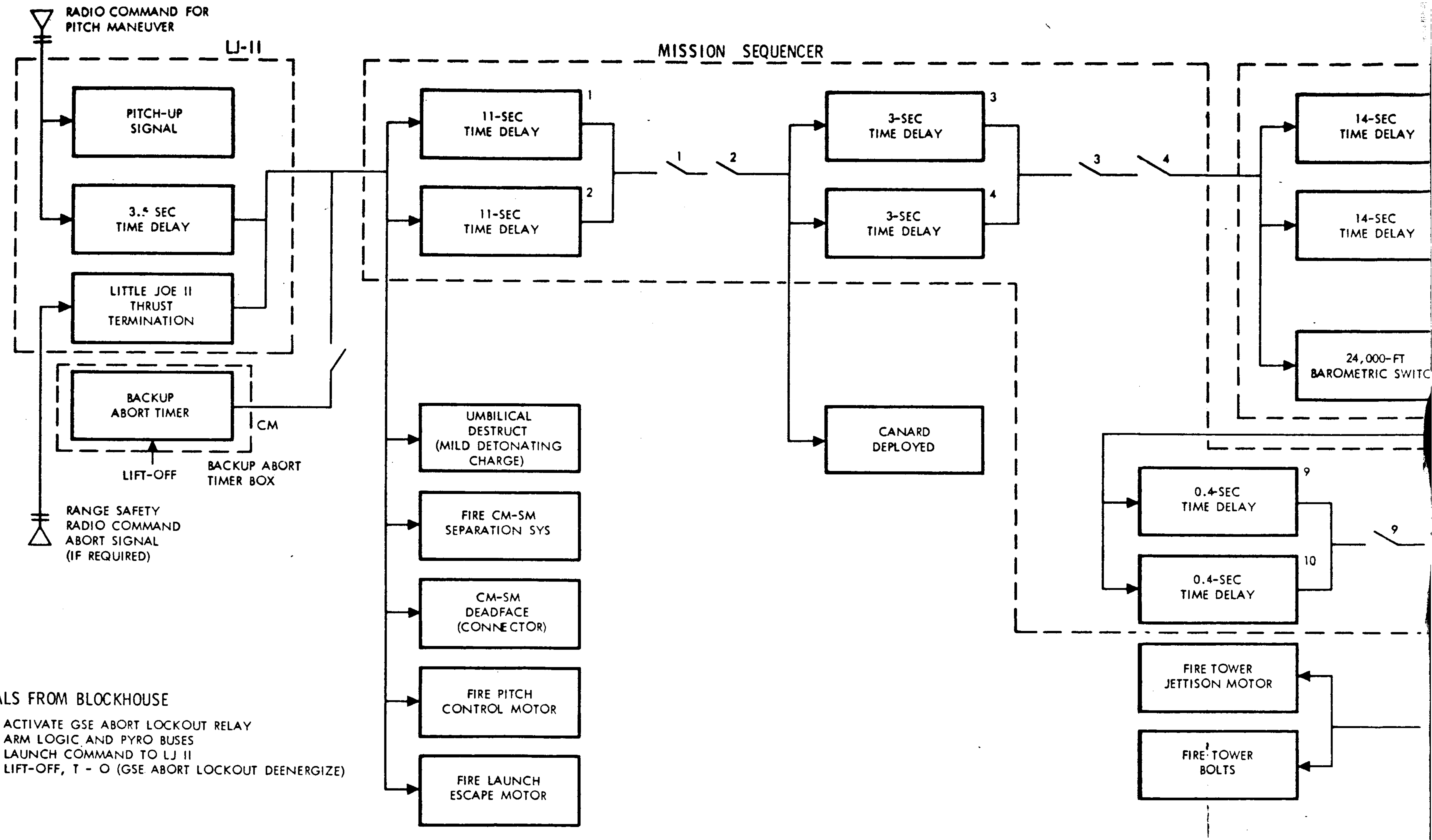


Figure 11. Spacecraft 002 Abort Region Envelope

[redacted]



SIGNALS FROM BLOCKHOUSE

1. ACTIVATE GSE ABORT LOCKOUT RELAY ARM LOGIC AND PYRO BUSES
2. LAUNCH COMMAND TO LJ II
3. LIFT-OFF, T - 0 (GSE ABORT LOCKOUT DEENERGIZE)

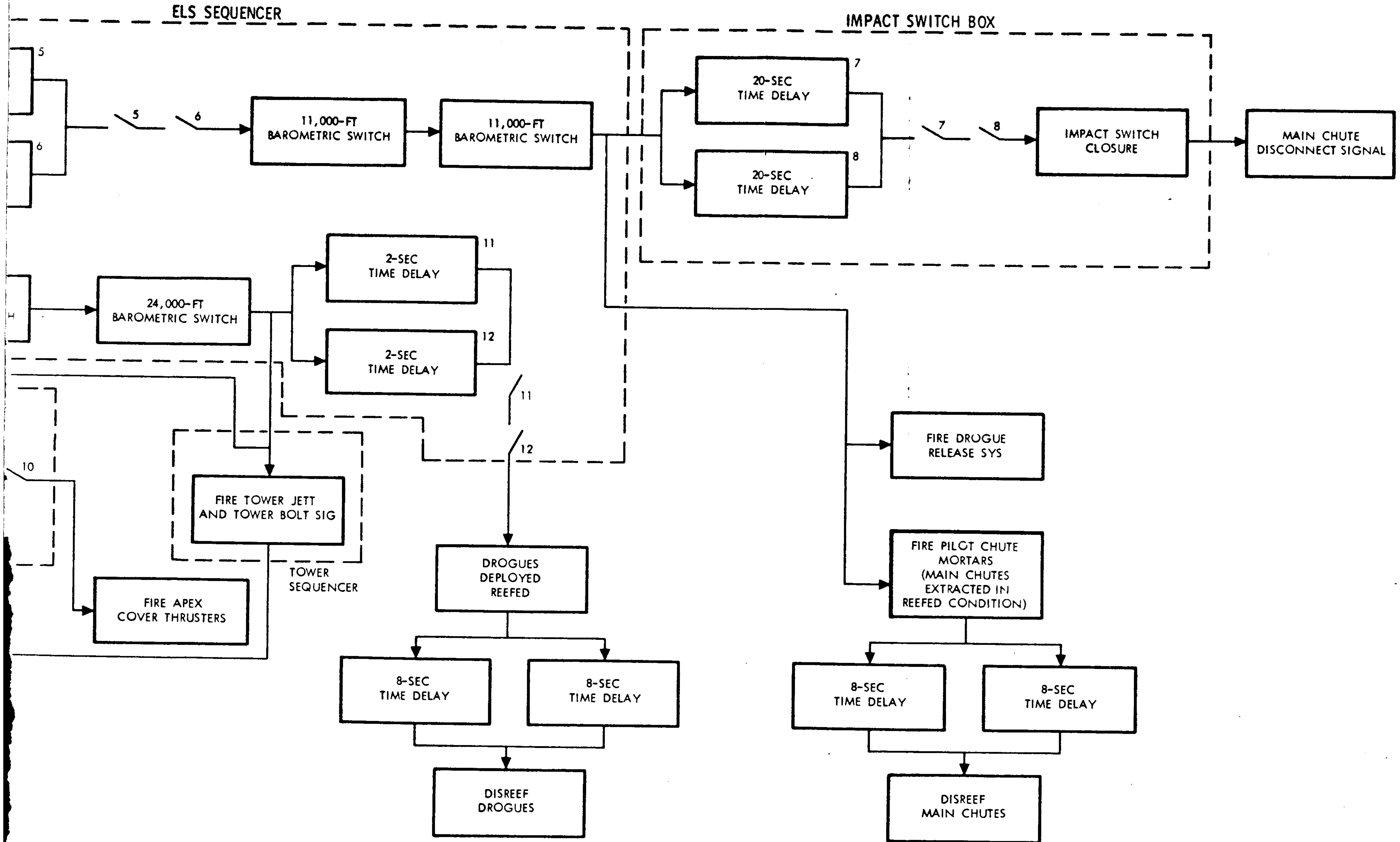


Figure 12. Mission Sequencer Subsystem

2

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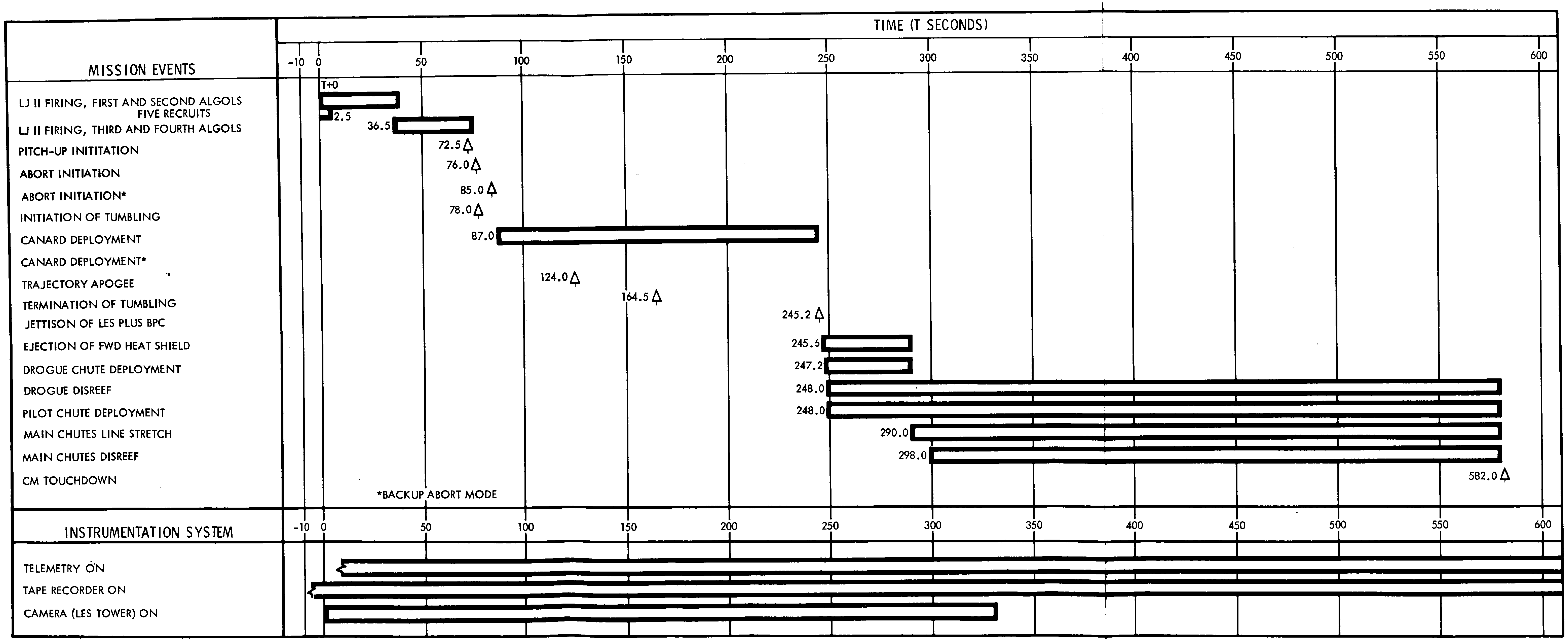

Figure 13. Operational Time Lines-Mission A-004

~~CONFIDENTIAL~~

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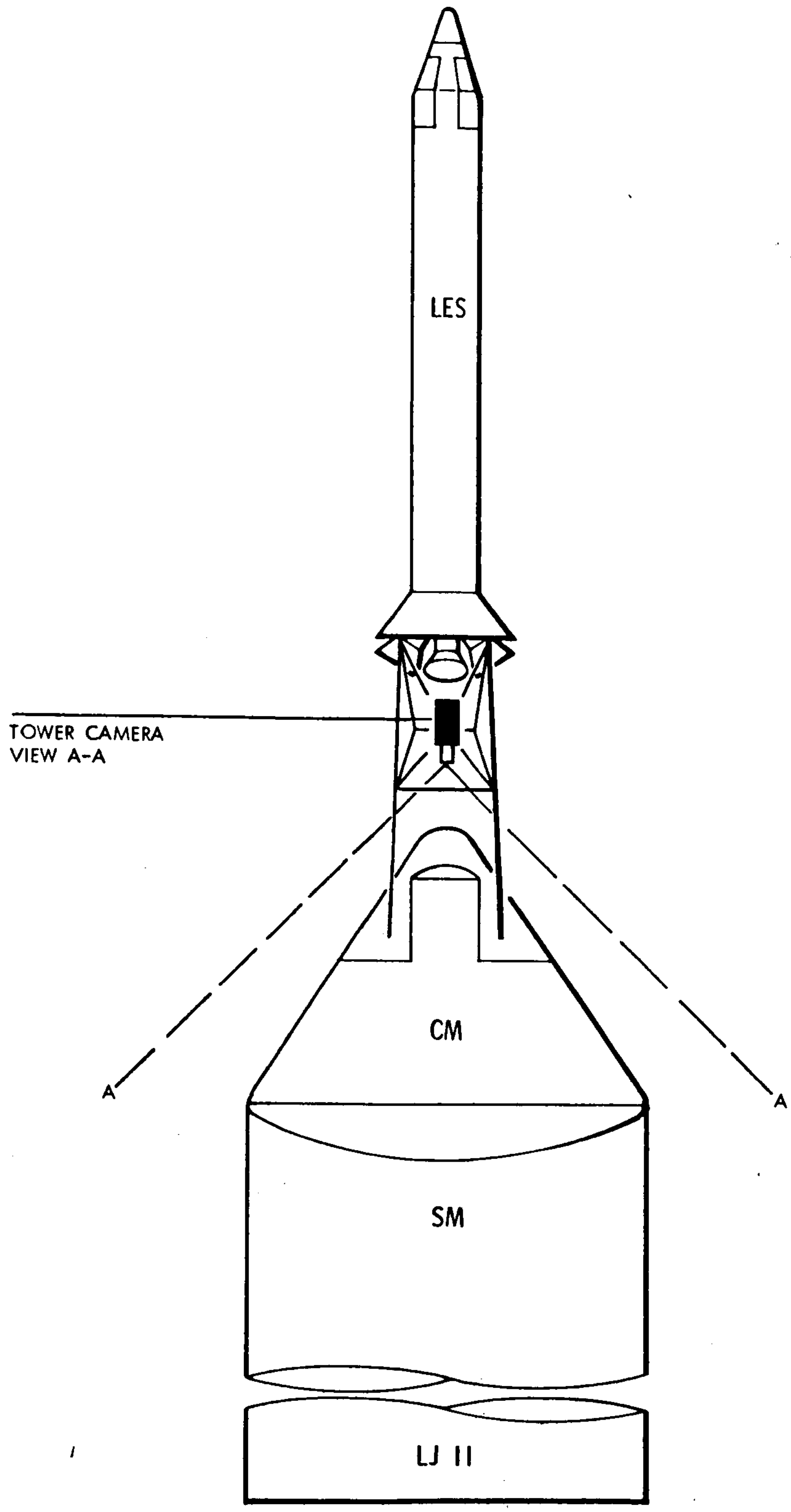

Figure 14. Onboard Camera Location

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[redacted]

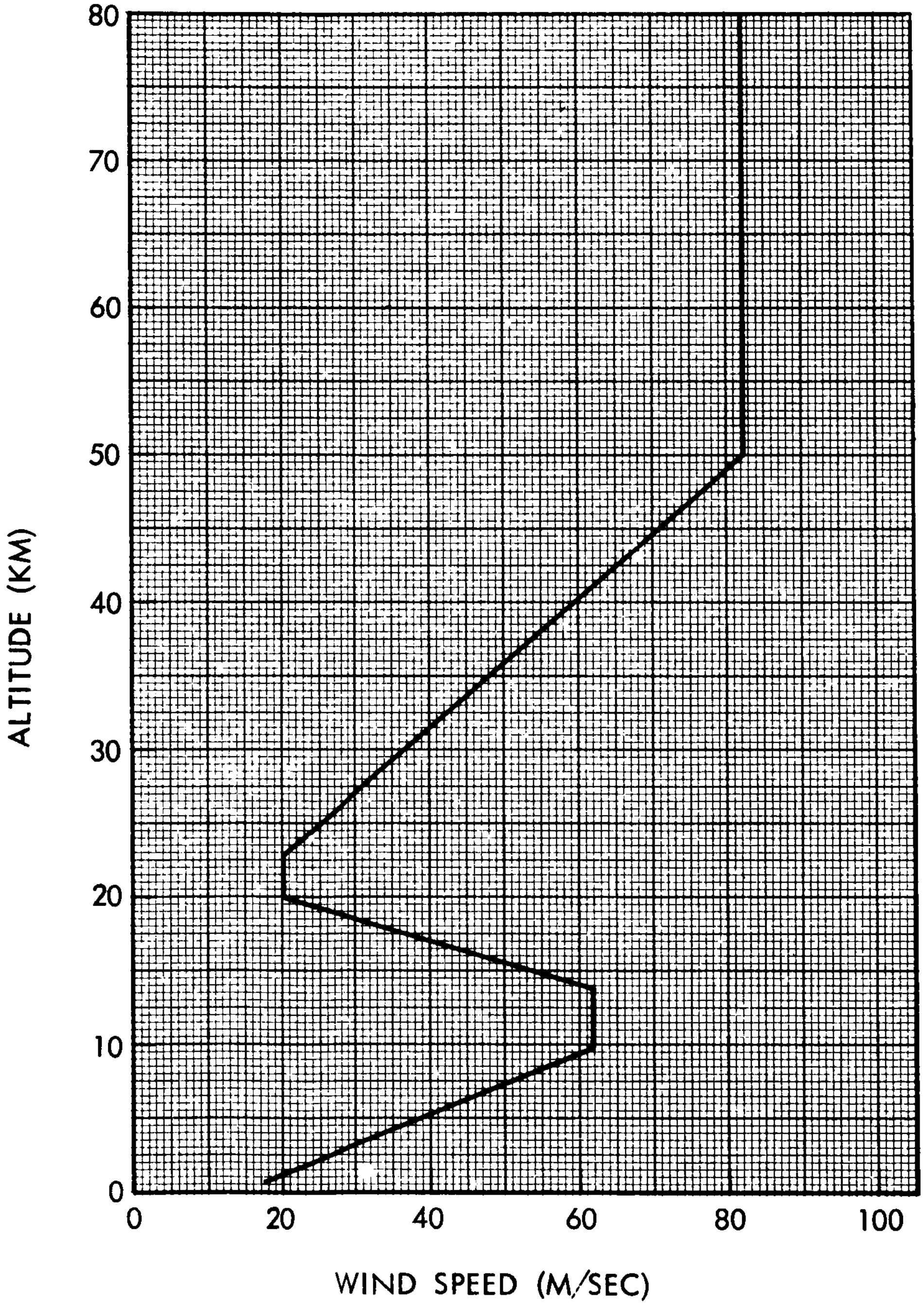

Figure 15. 88 Percentile Scalar Wind Speed Profile Envelope (Quasi-Steady-State)

[redacted]

[redacted]

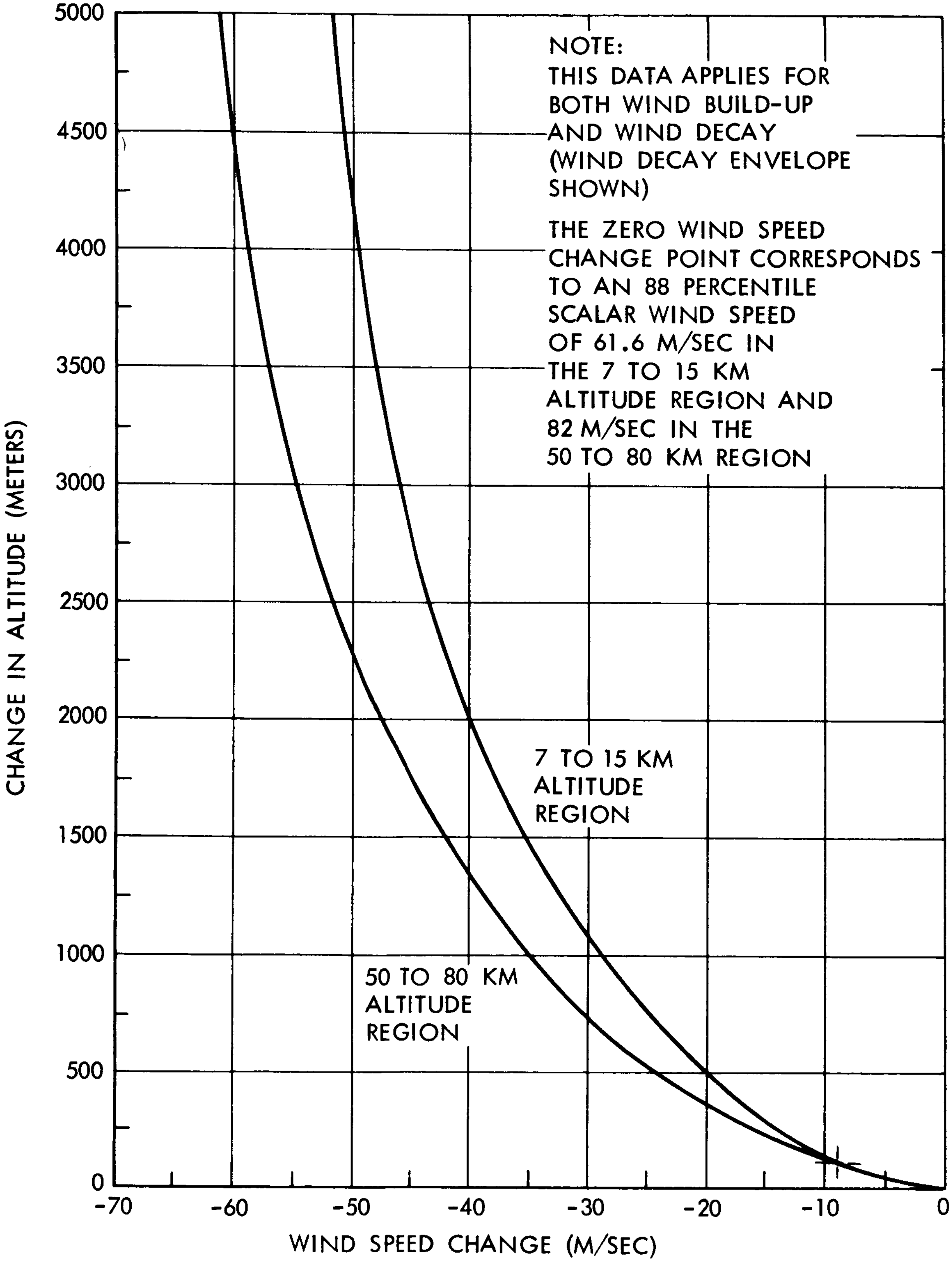

Figure 16. Wind Speed Change Envelopes (99 Percentile)

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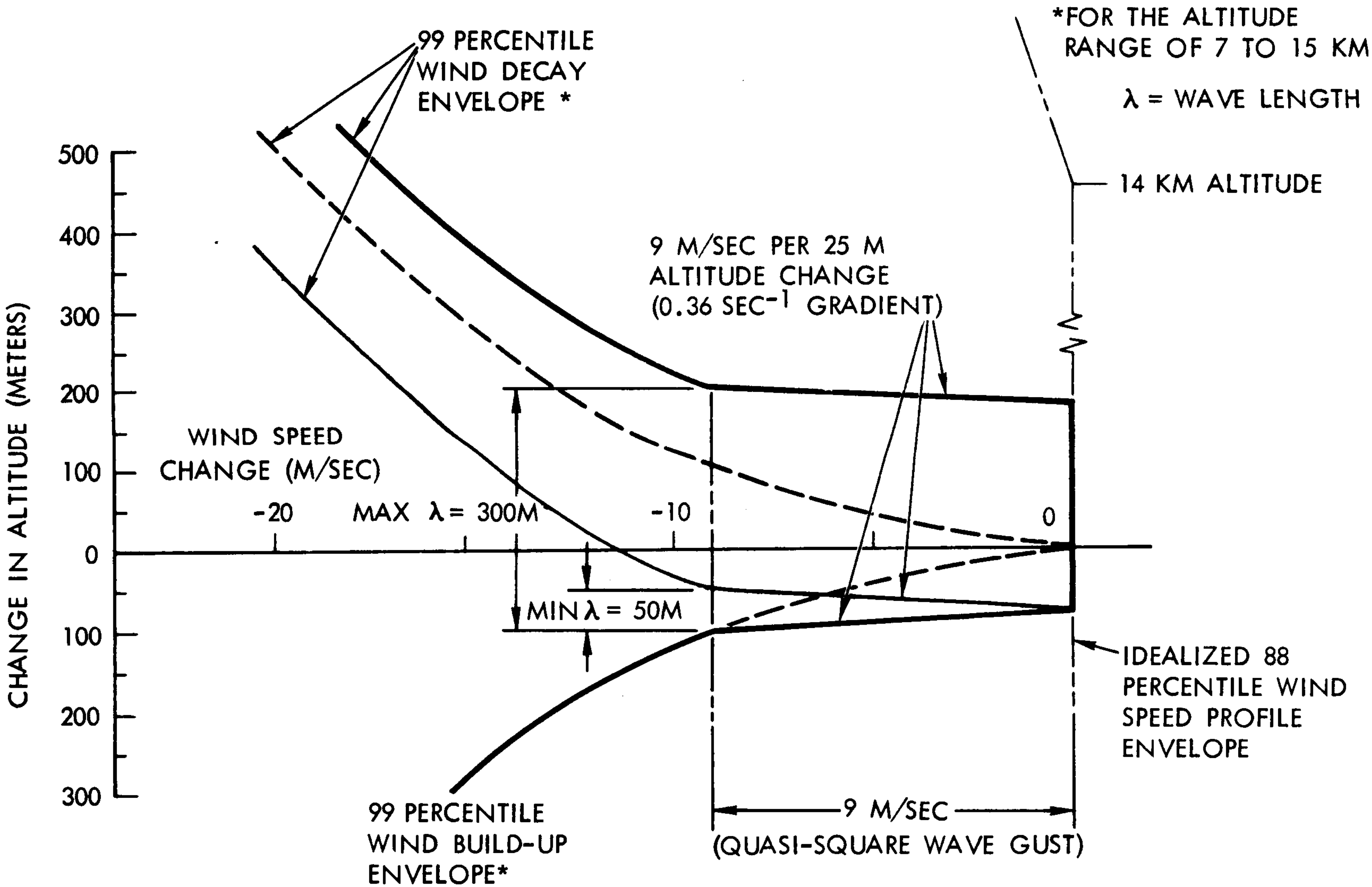

Figure 17. Relationship Between the Quasi-Square Wave Gust, Idealized Wind Speed Profile Envelope, and Wind Speed Change

[redacted]

QUASI-STEADY STATE WIND SPEED ($\pm$ 5 M SEC^{-1})	MINIMUM THICKNESS (KM)	MAXIMUM THICKNESS (KM)	ALTITUDE RANGE (KM)
50	0	5	8.5 TO 16.5
75	0	3	10.5 TO 15.5

Figure 18. Allowable Altitude Thickness of Synthetic Profile Peak Wind

[redacted]

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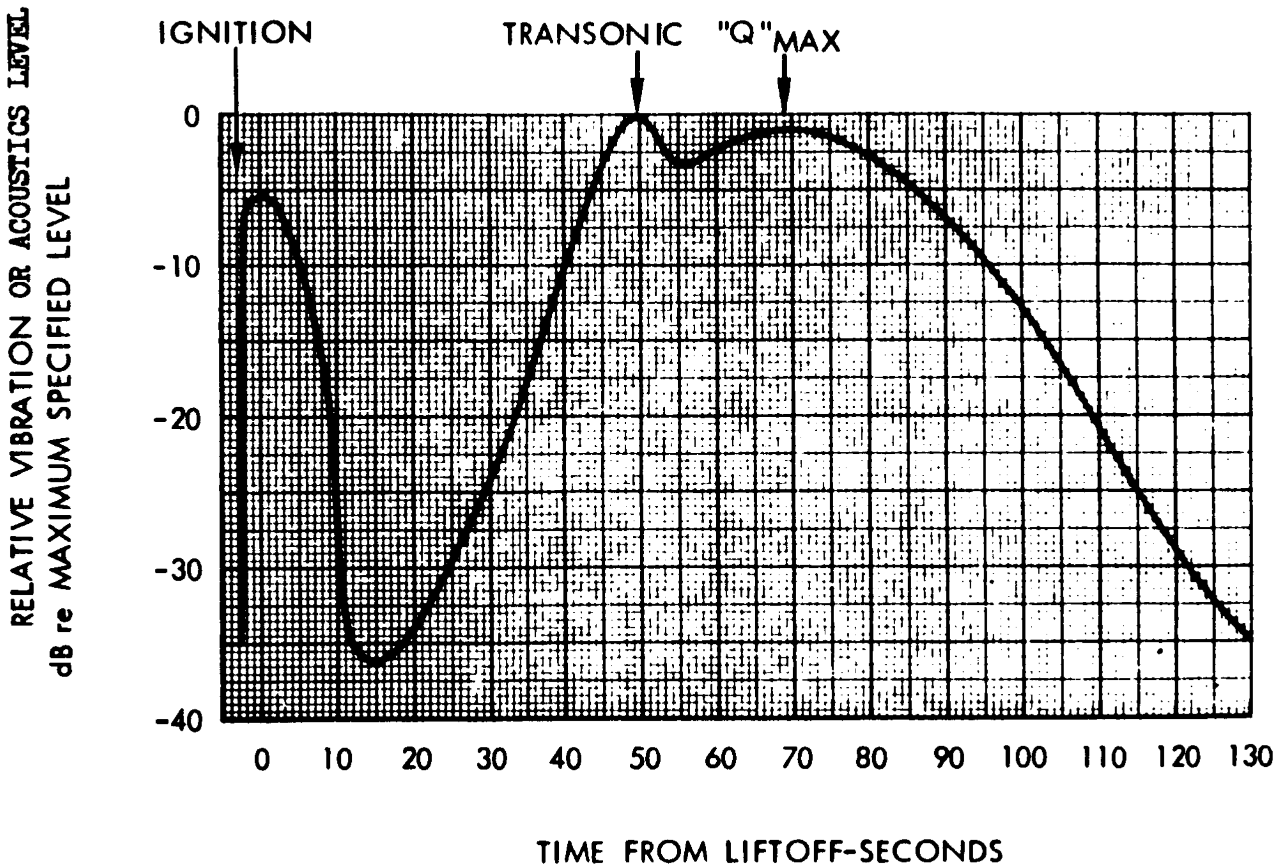

Figure 19. Vibration and Acoustics Time History - Atmospheric Flight

[redacted]

[redacted]

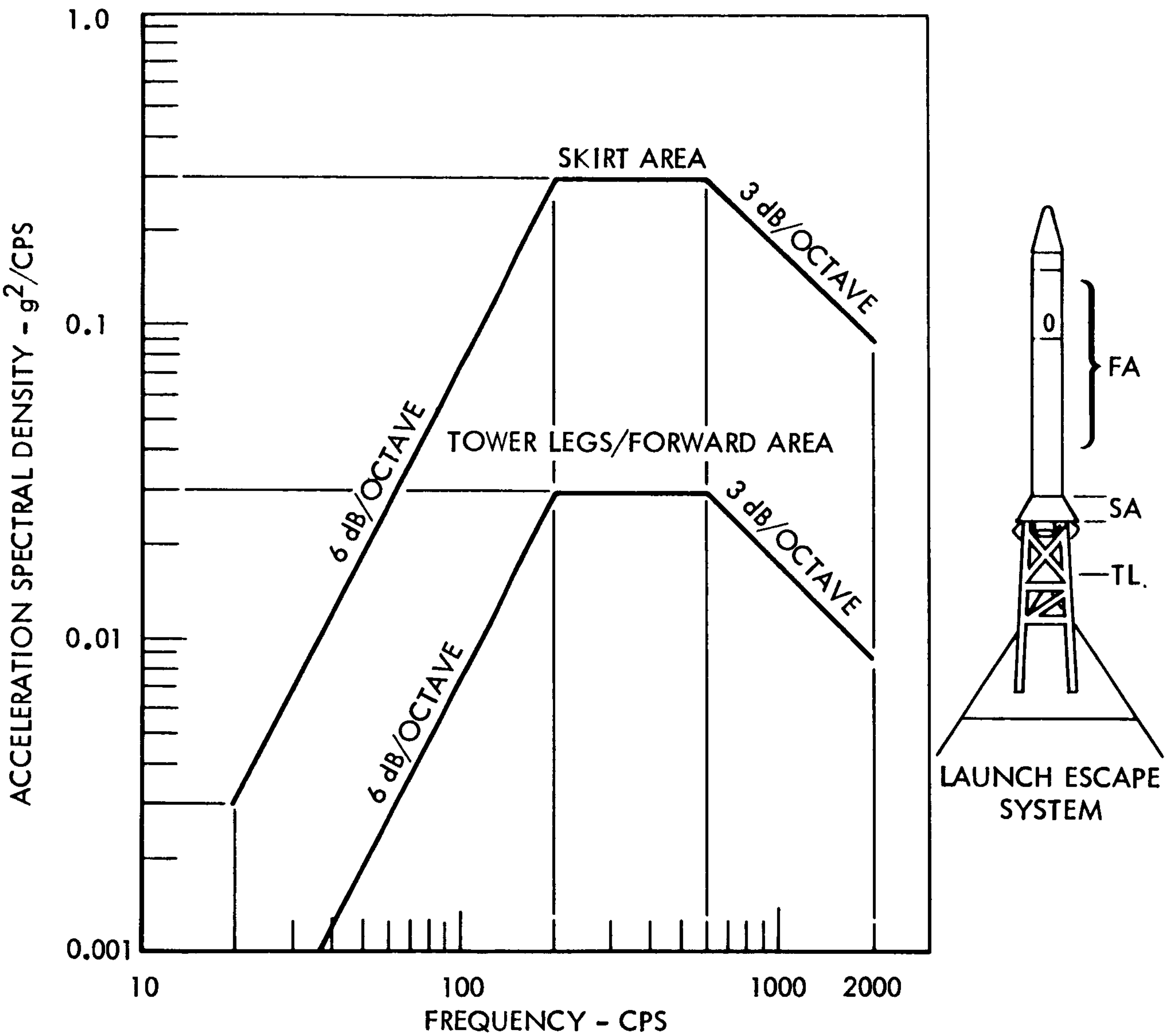

Figure 20. Vibration LES - Atmospheric Flight

[redacted]

[redacted]

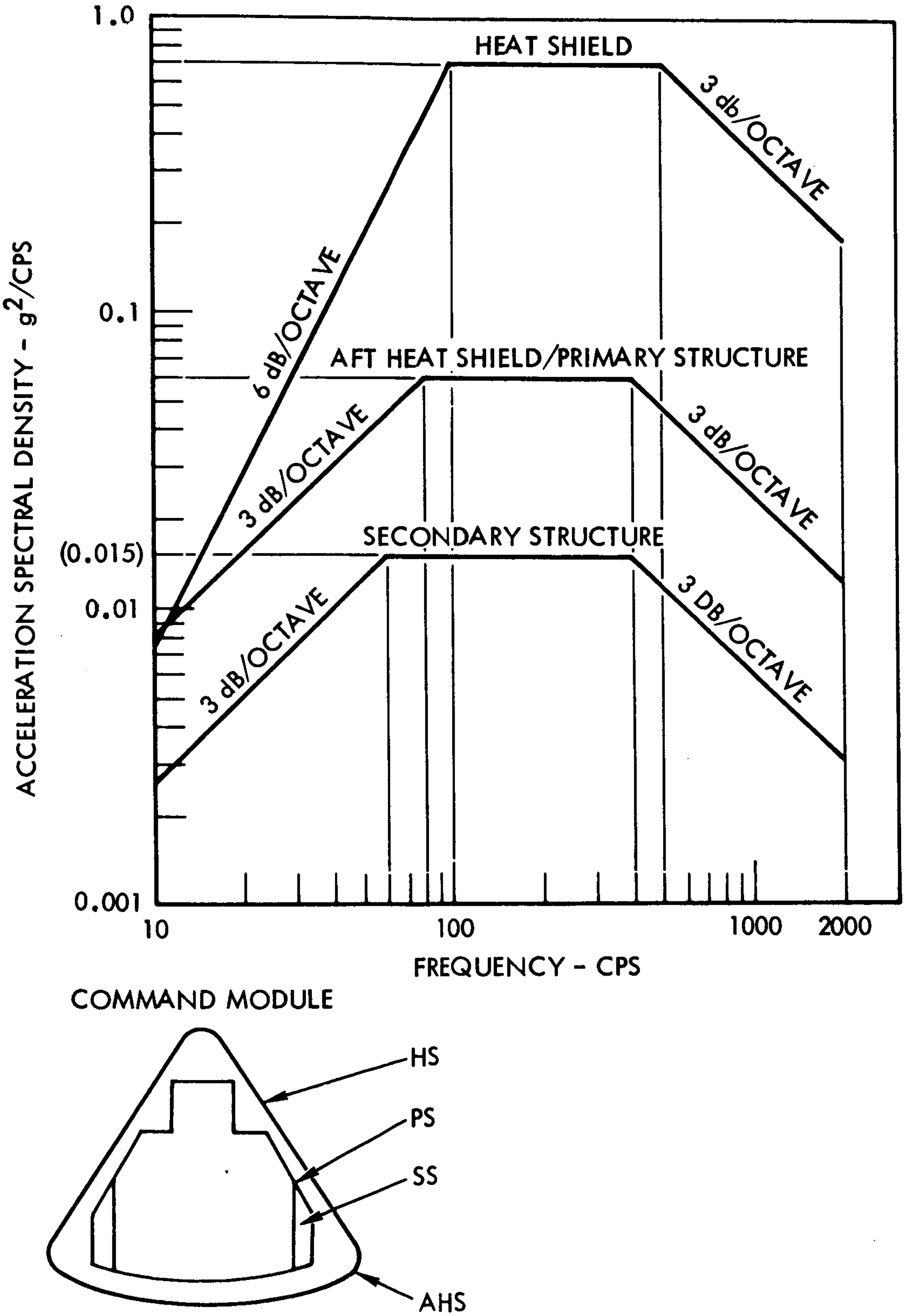

Figure 21. Vibration CM - Atmospheric Flight (Ascent)

[redacted]

[redacted]

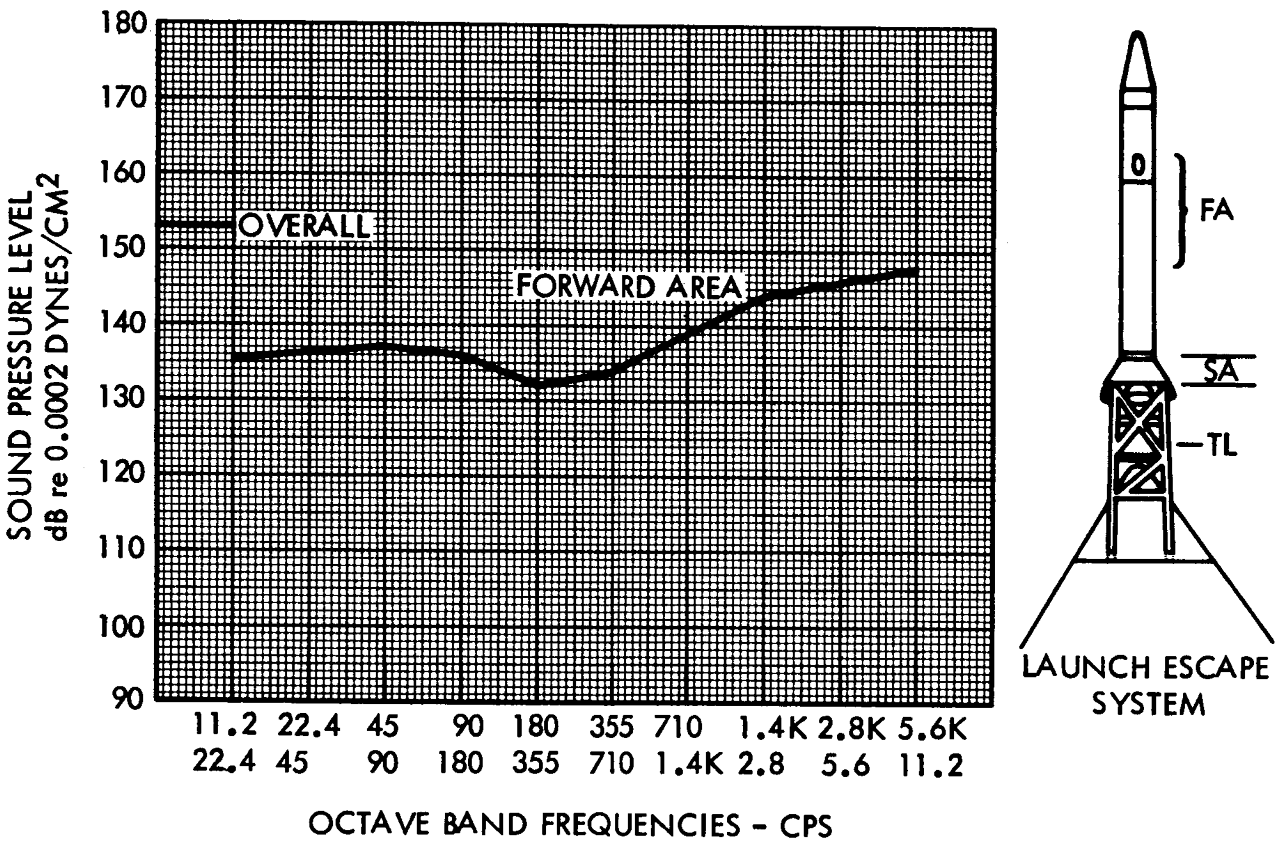

Figure 22. Acoustics LES - Atmospheric Flight - Forward Area

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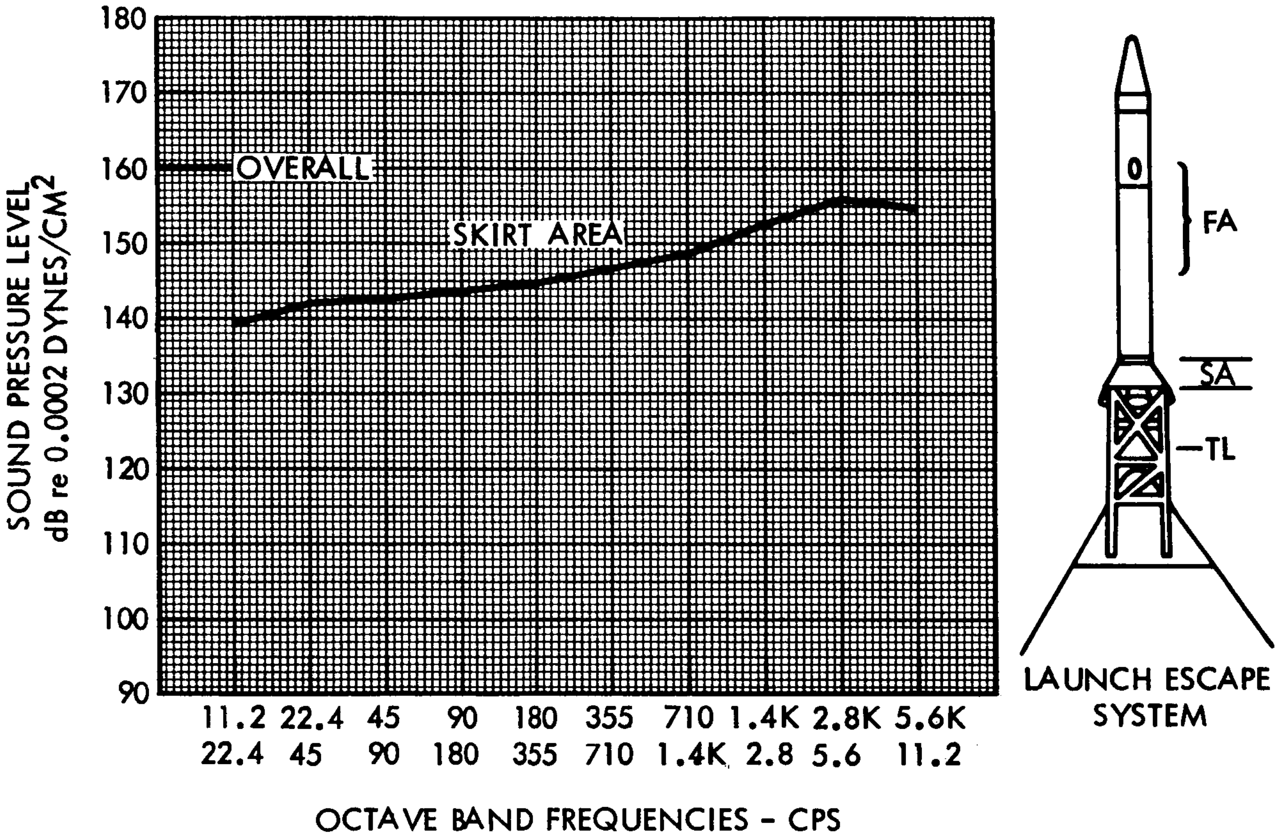

Figure 23. Acoustics LES - Atmospheric Flight - Skirt Area

[redacted]

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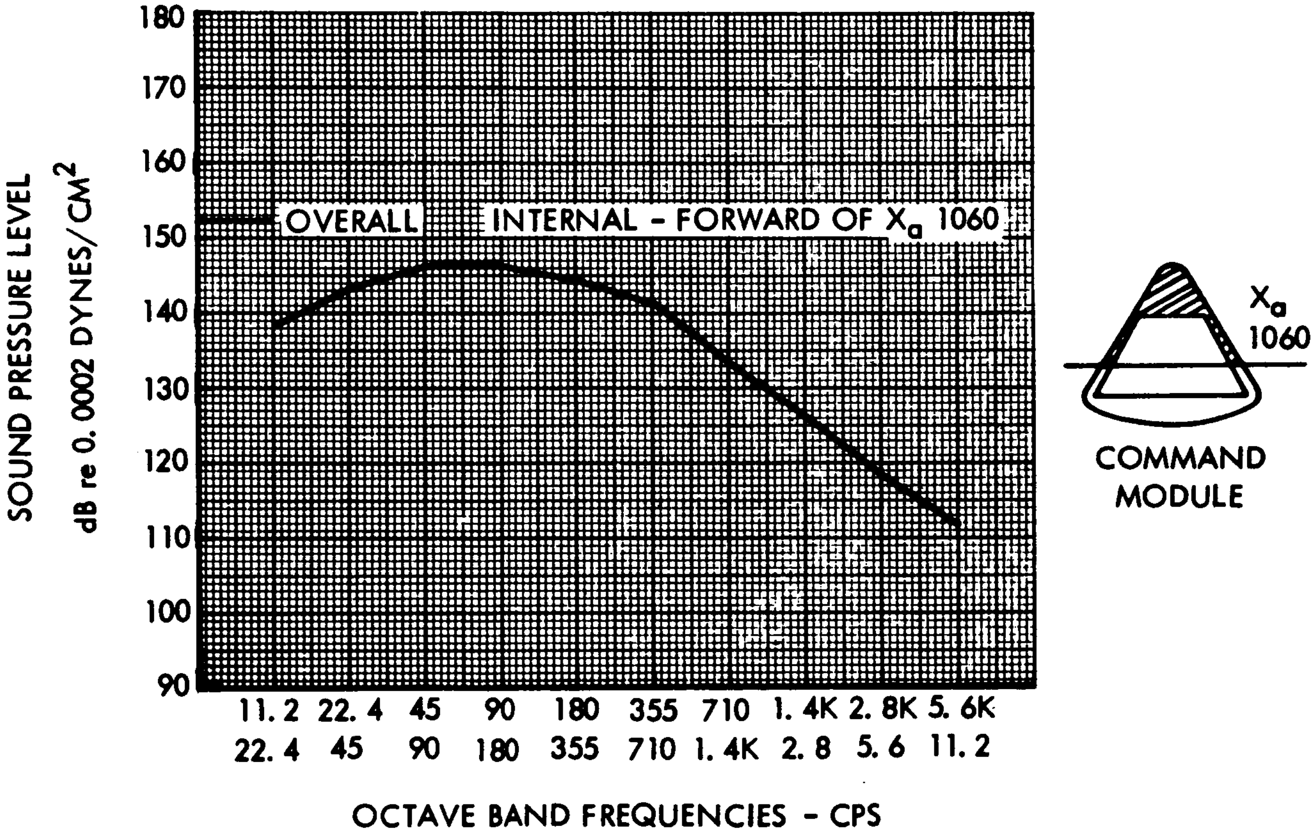

Figure 24. Acoustics CM - Atmoshperic Flight - Internal - Forward Xa1060

[redacted]

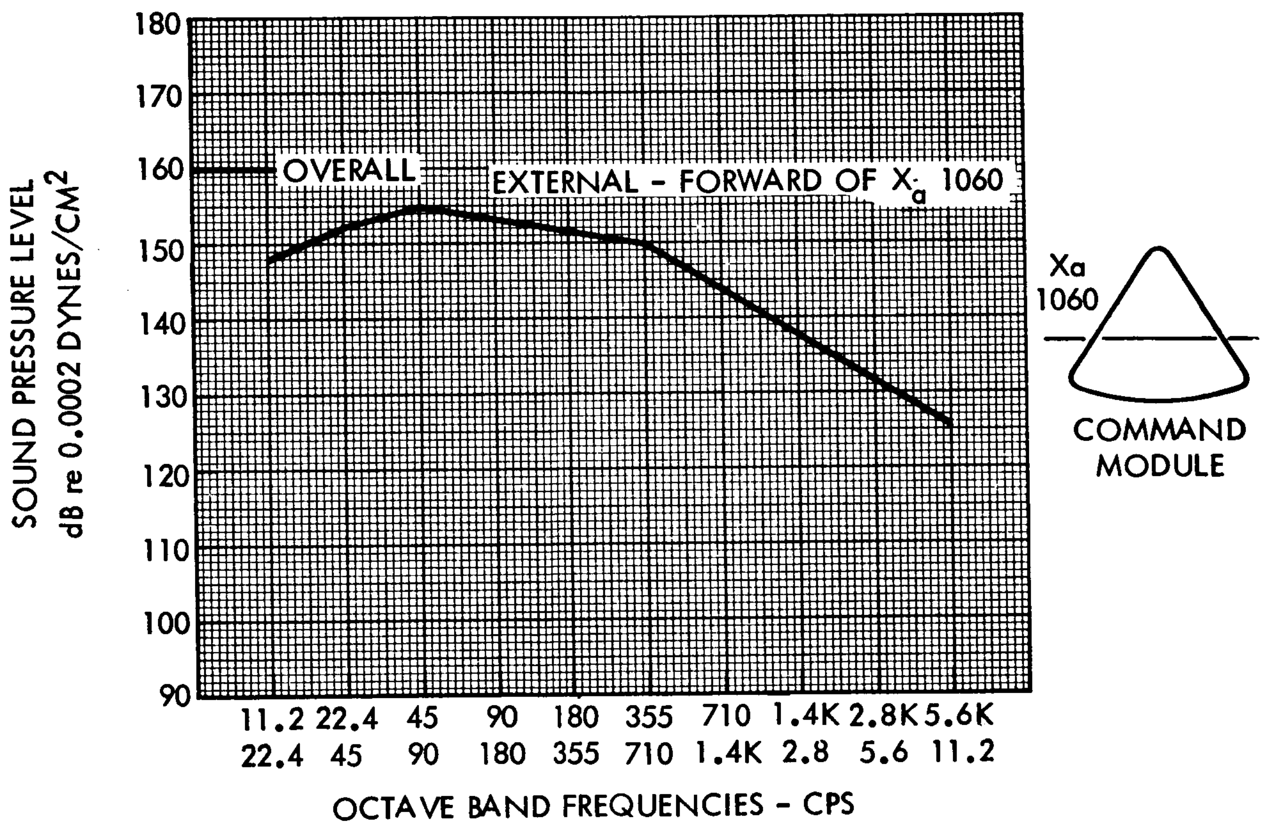

Figure 25. Acoustics CM - Atmospheric Flight - External - Forward Xa1060

[redacted]

[redacted]

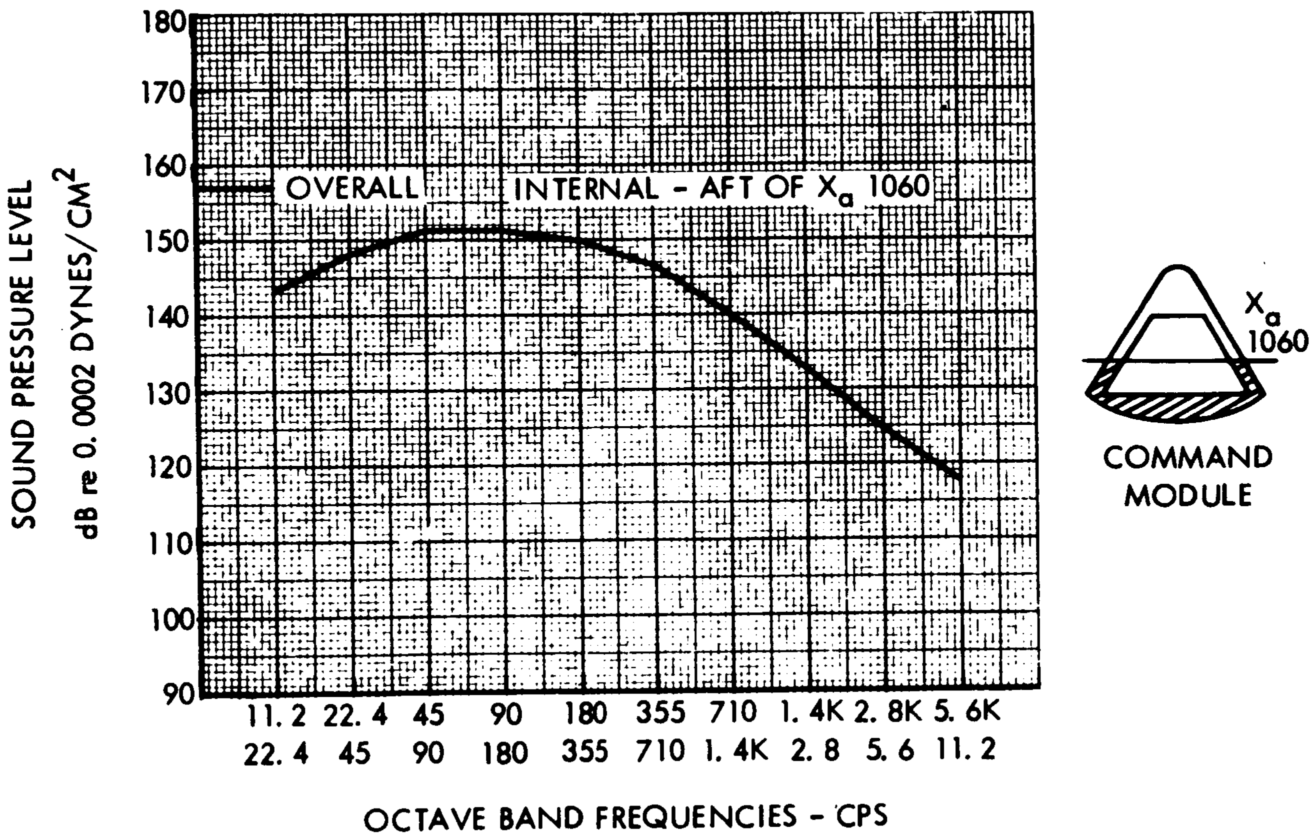

Figure 26, Acoustics CM - Atmospheric Flight - Internal - Aft Xa1060

[redacted]

[redacted]

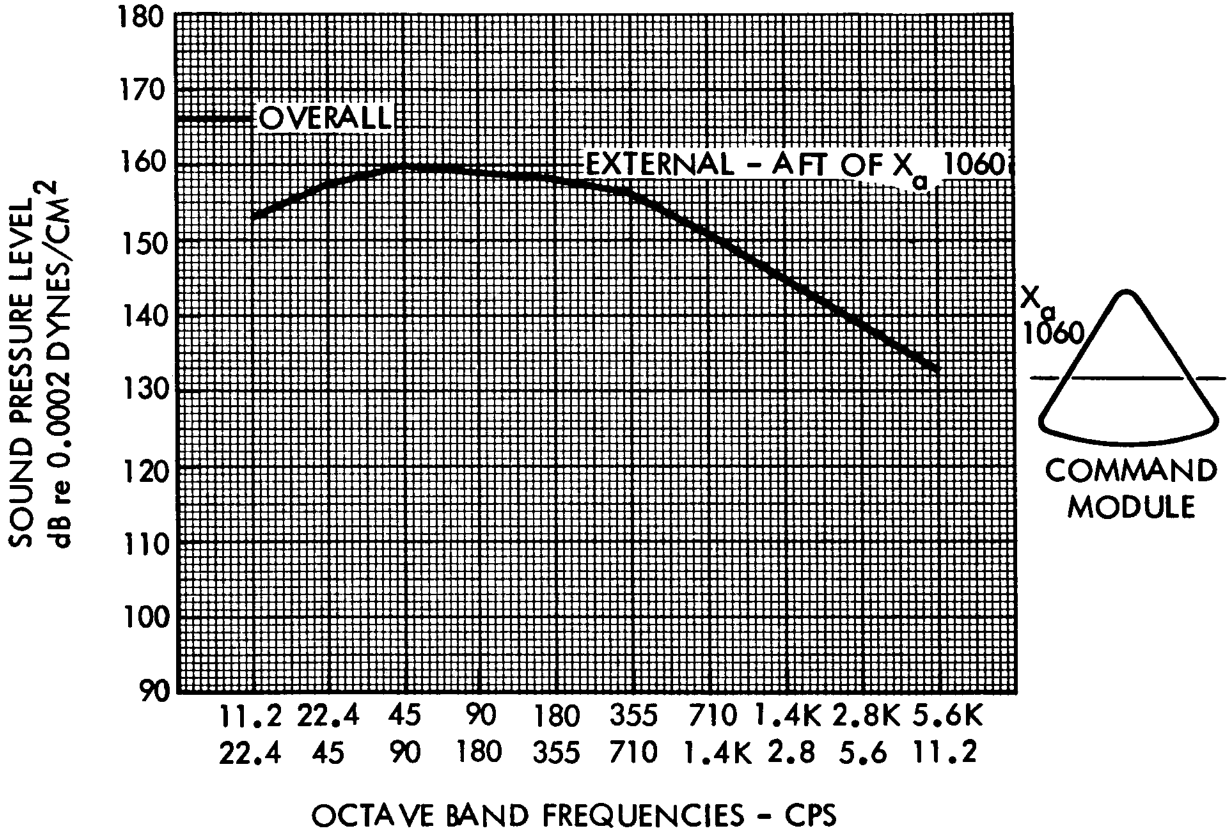

Figure 27. Acoustics CM - Atmospheric Flight - External - Aft Xa1060

[redacted]

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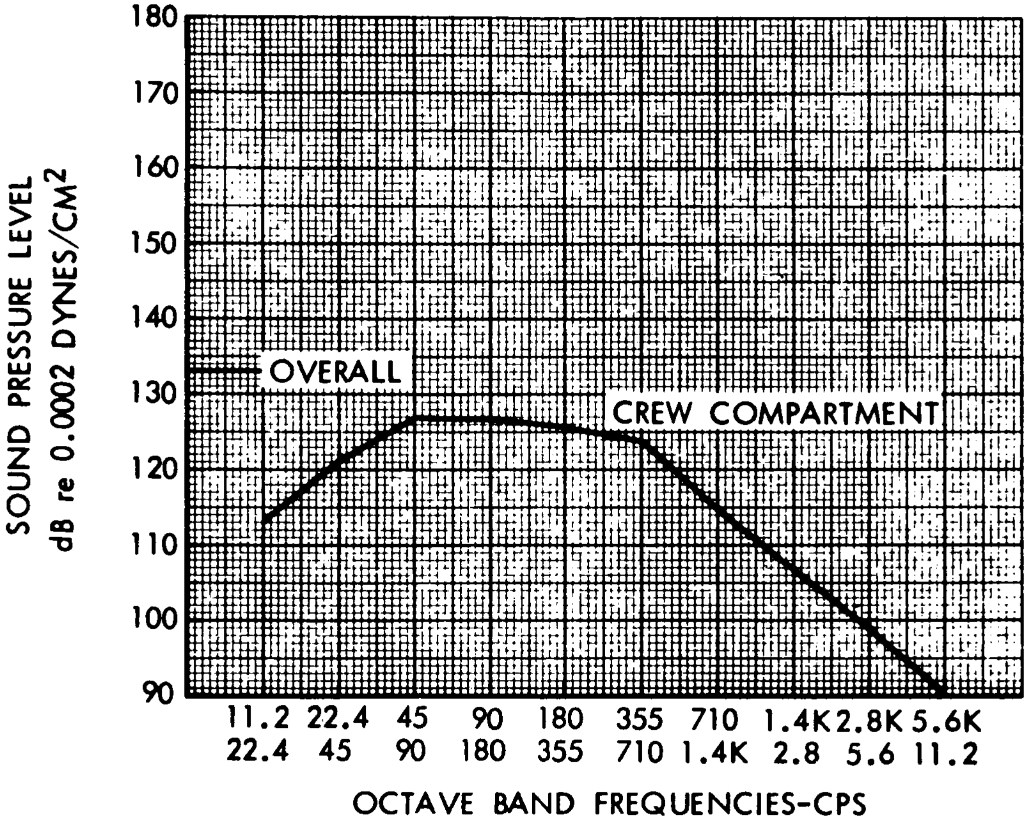

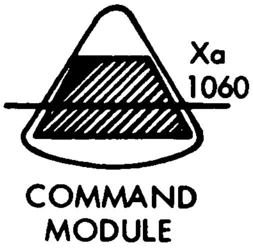

Figure 28. Acoustics CM - Atmospheric Flight - Crew Compartment

[redacted]

[redacted]

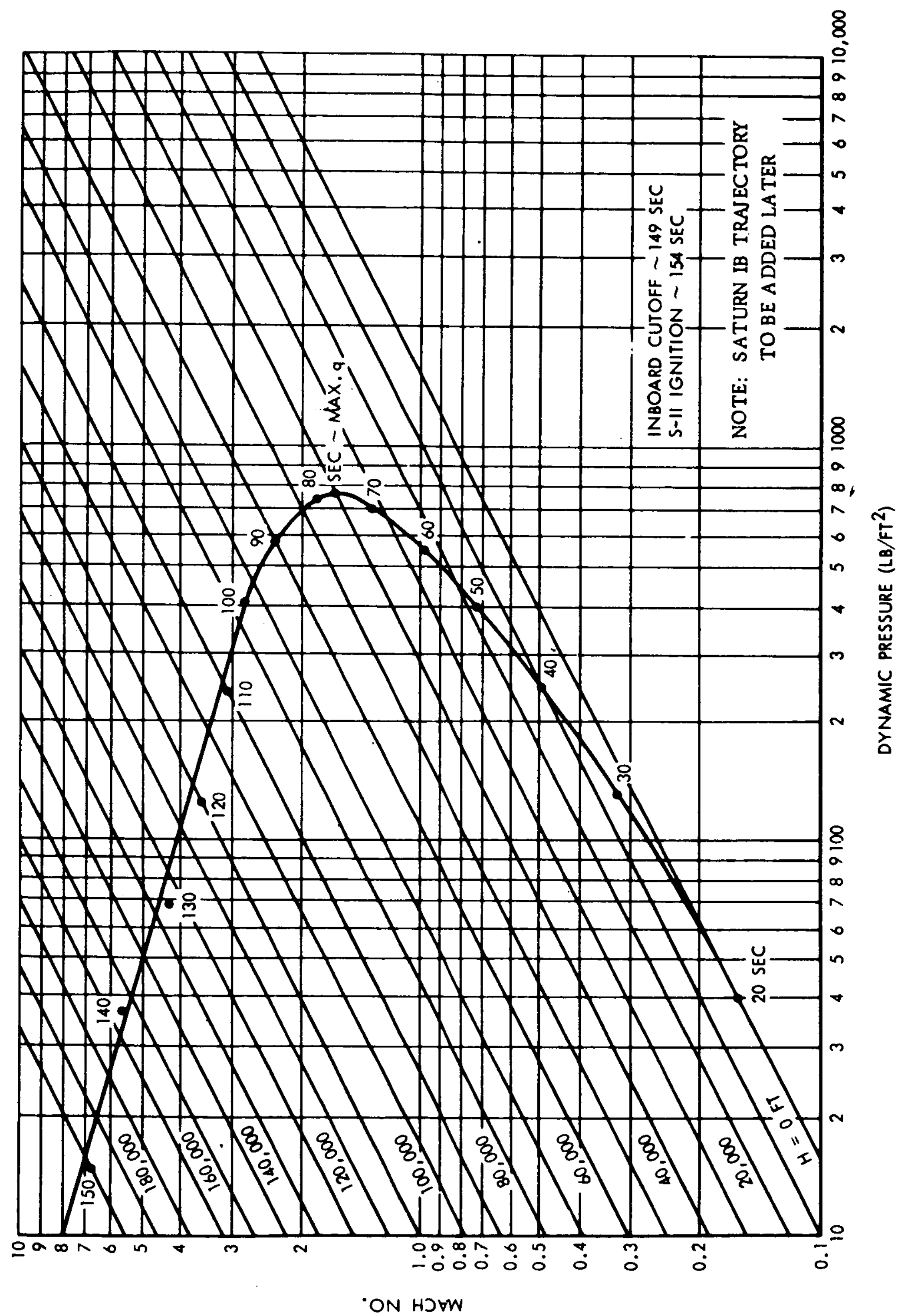

Figure 29. Saturn V Two-Stage Boost Trajectory - 100 NM Orbit

[redacted]

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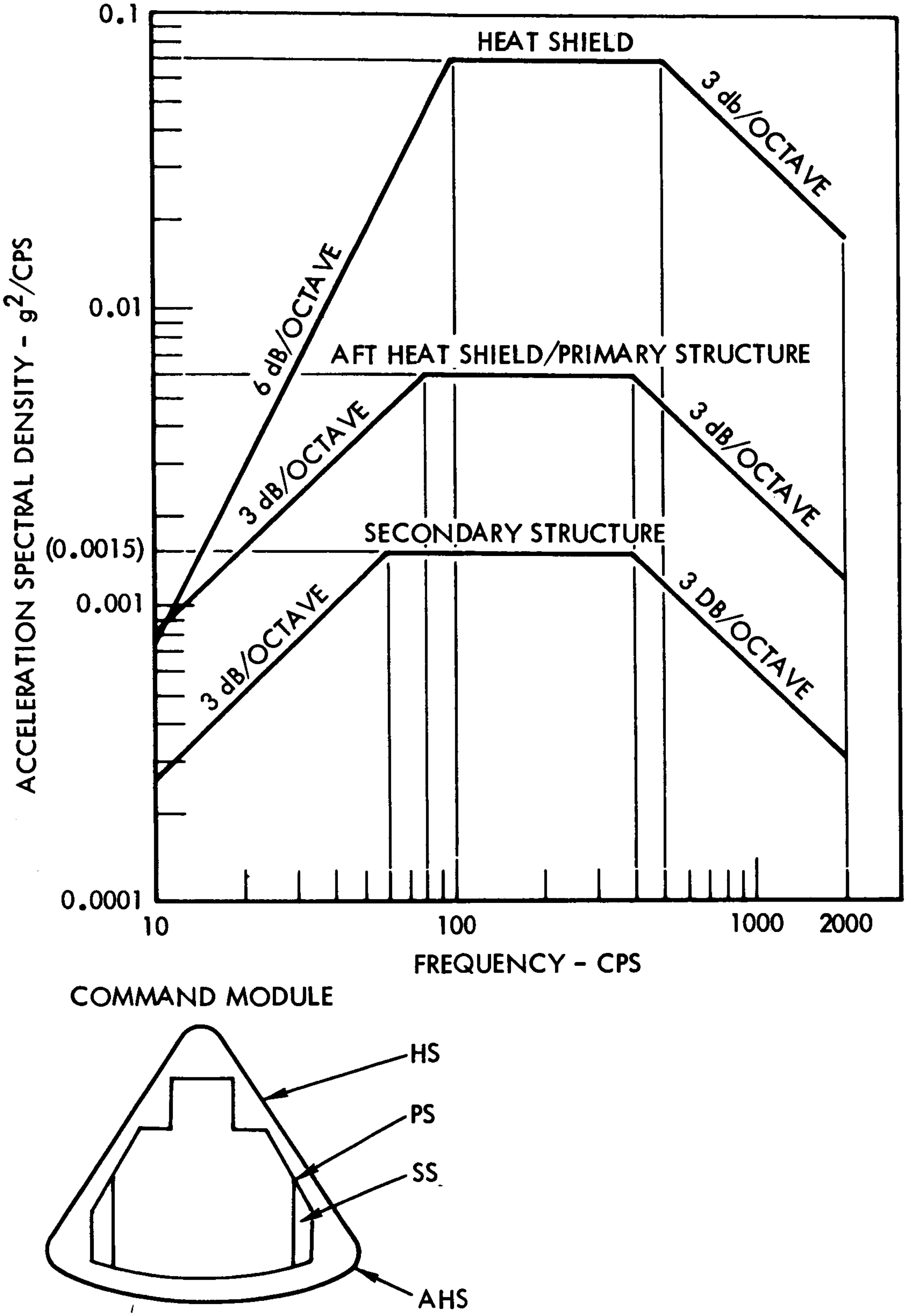


Figure 30. Vibration CM-Entry

[redacted]

[redacted]

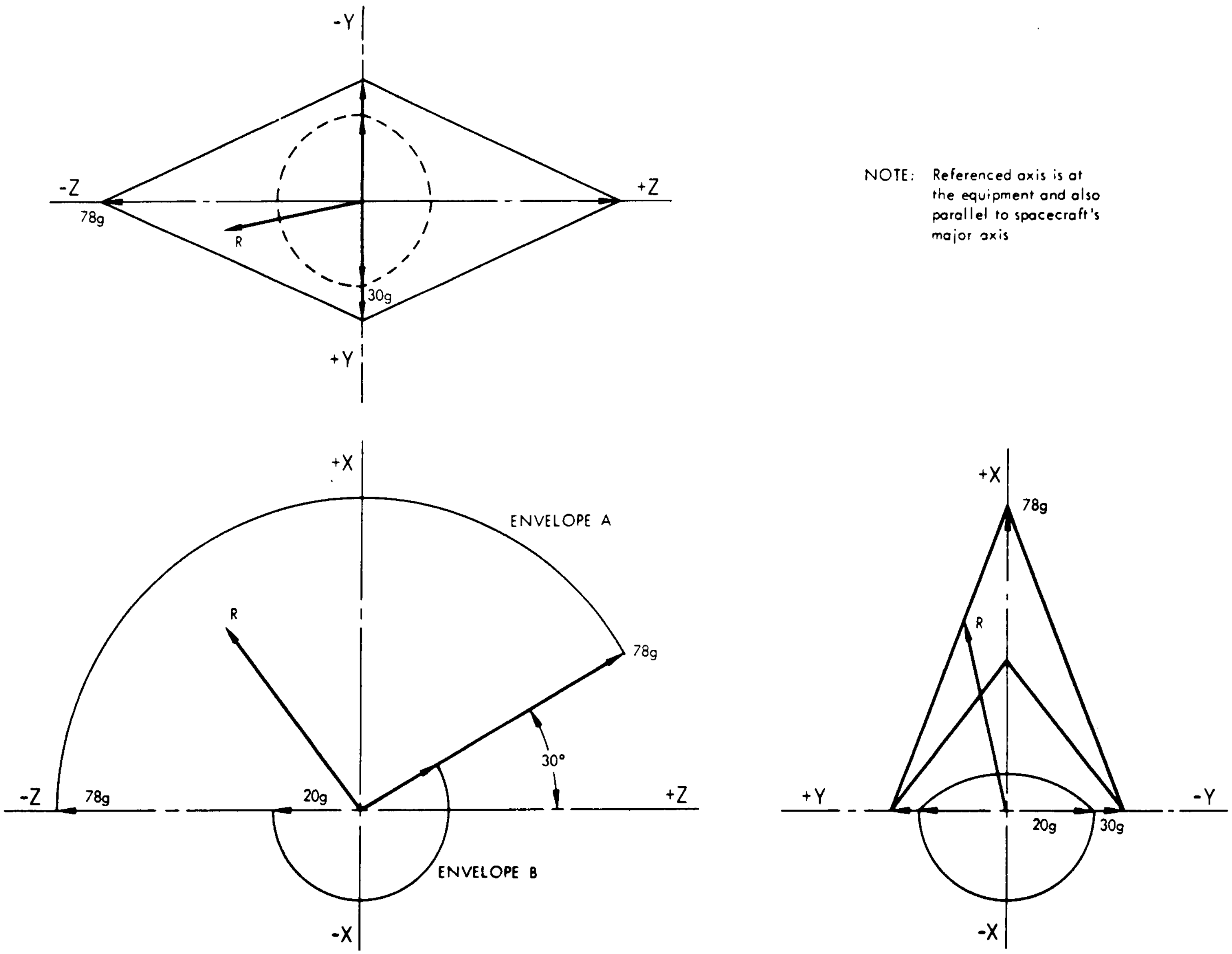


Figure 31. Internal Equipment Ultimate Design Accelerations Diagram I

[redacted]

[redacted]

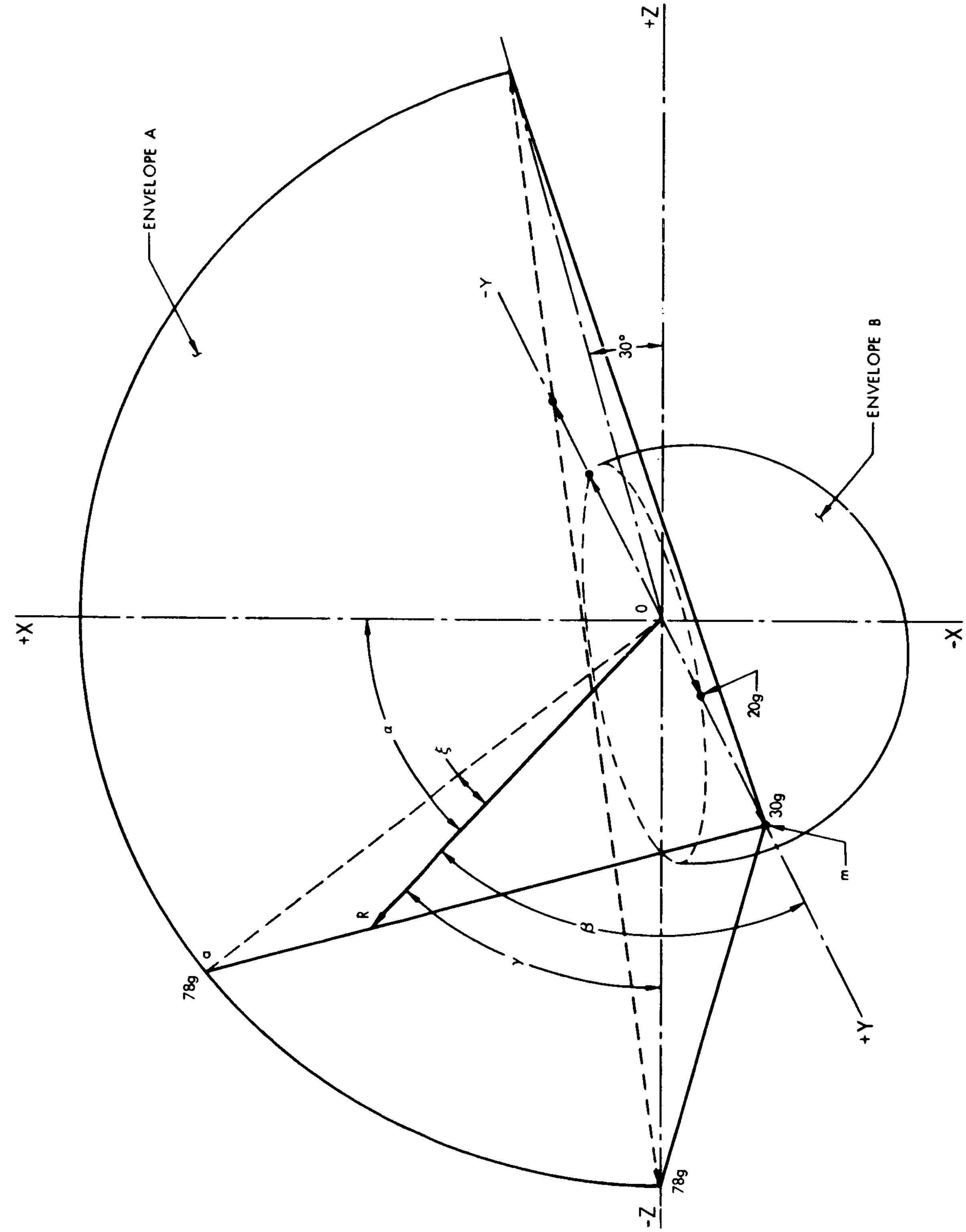


Figure 32. Internal Equipment Ultimate Design Accelerations Diagram II

[redacted]

[redacted]

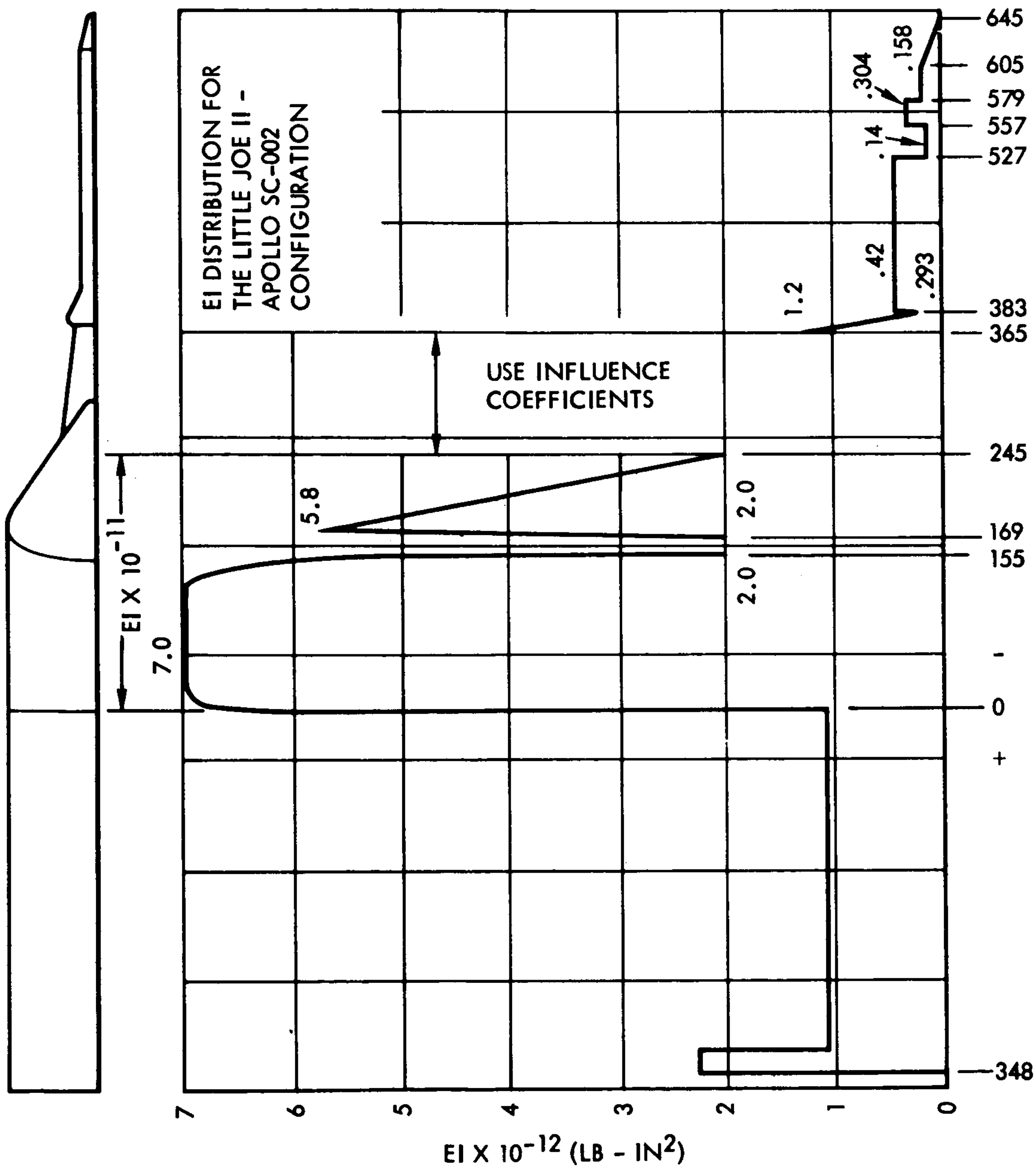


Figure 33. Little Joe II/Apollo Vehicle Bending Stiffness

[redacted]

[redacted]

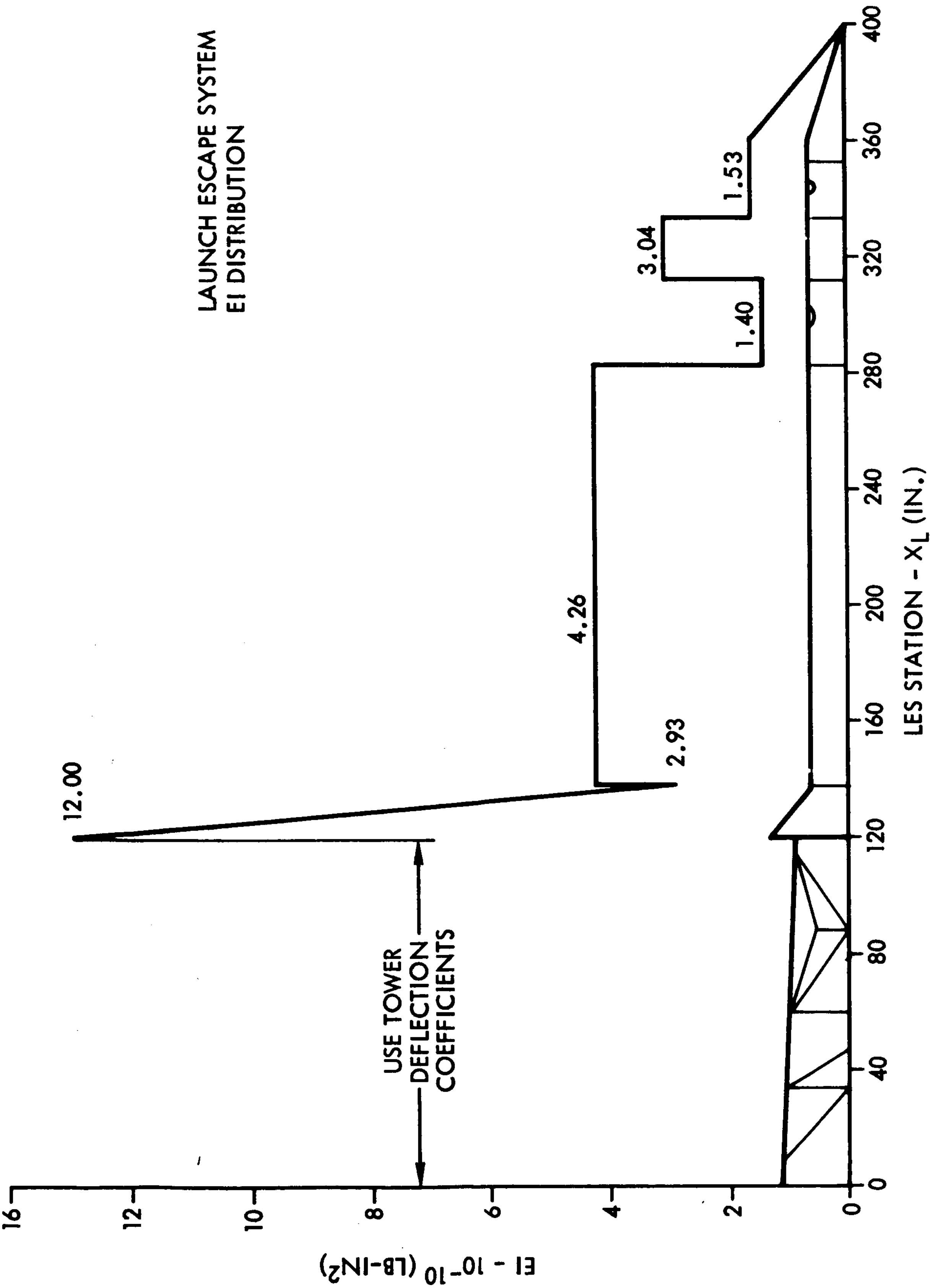


Figure 34. Block I Launch Escape Subsystem Bending Stiffness Distribution

[redacted]

[redacted]

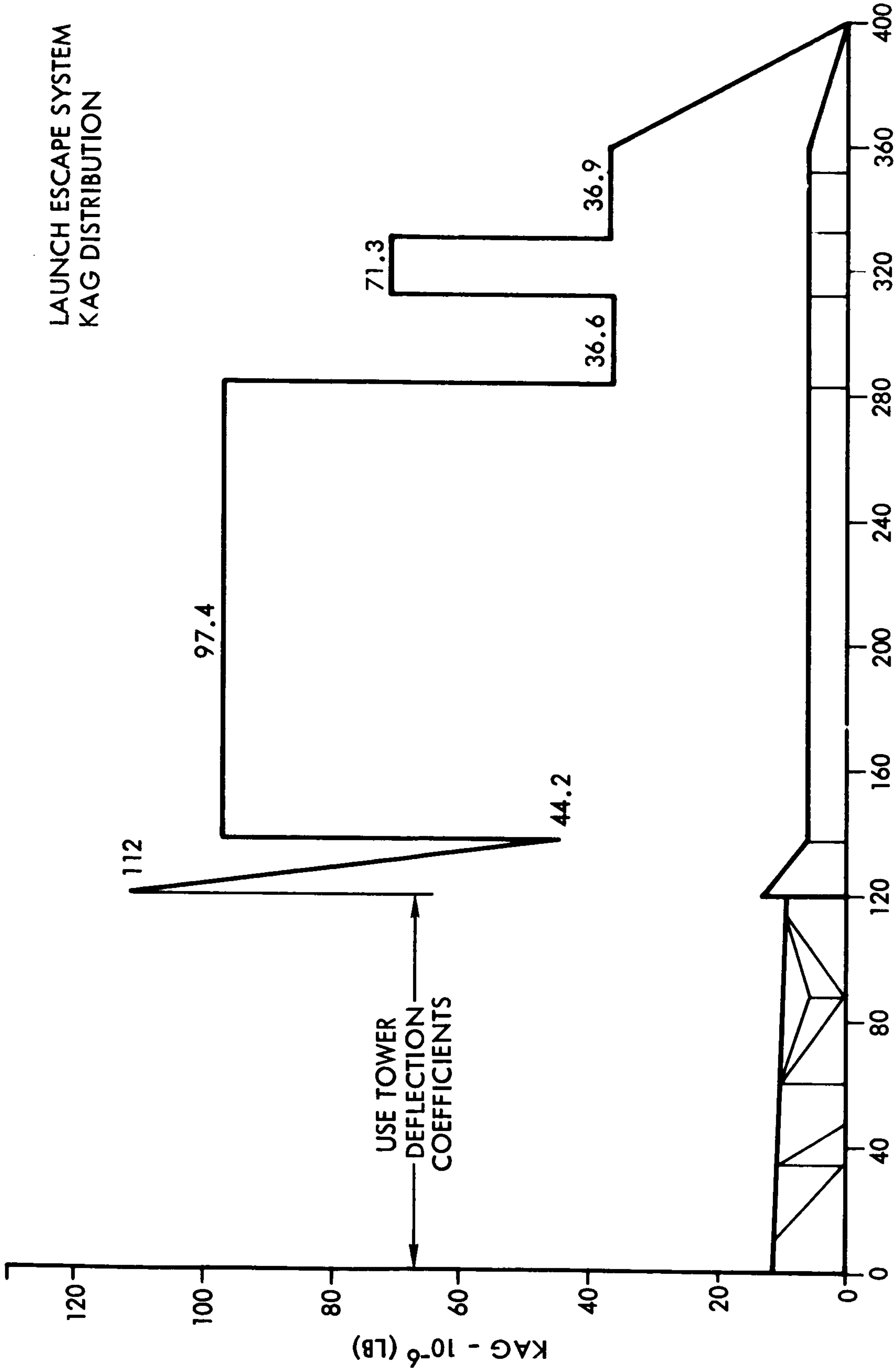


Figure 35. Block I Launch Escape Subsystem Shear Stiffness Distribution

[redacted]

[redacted]

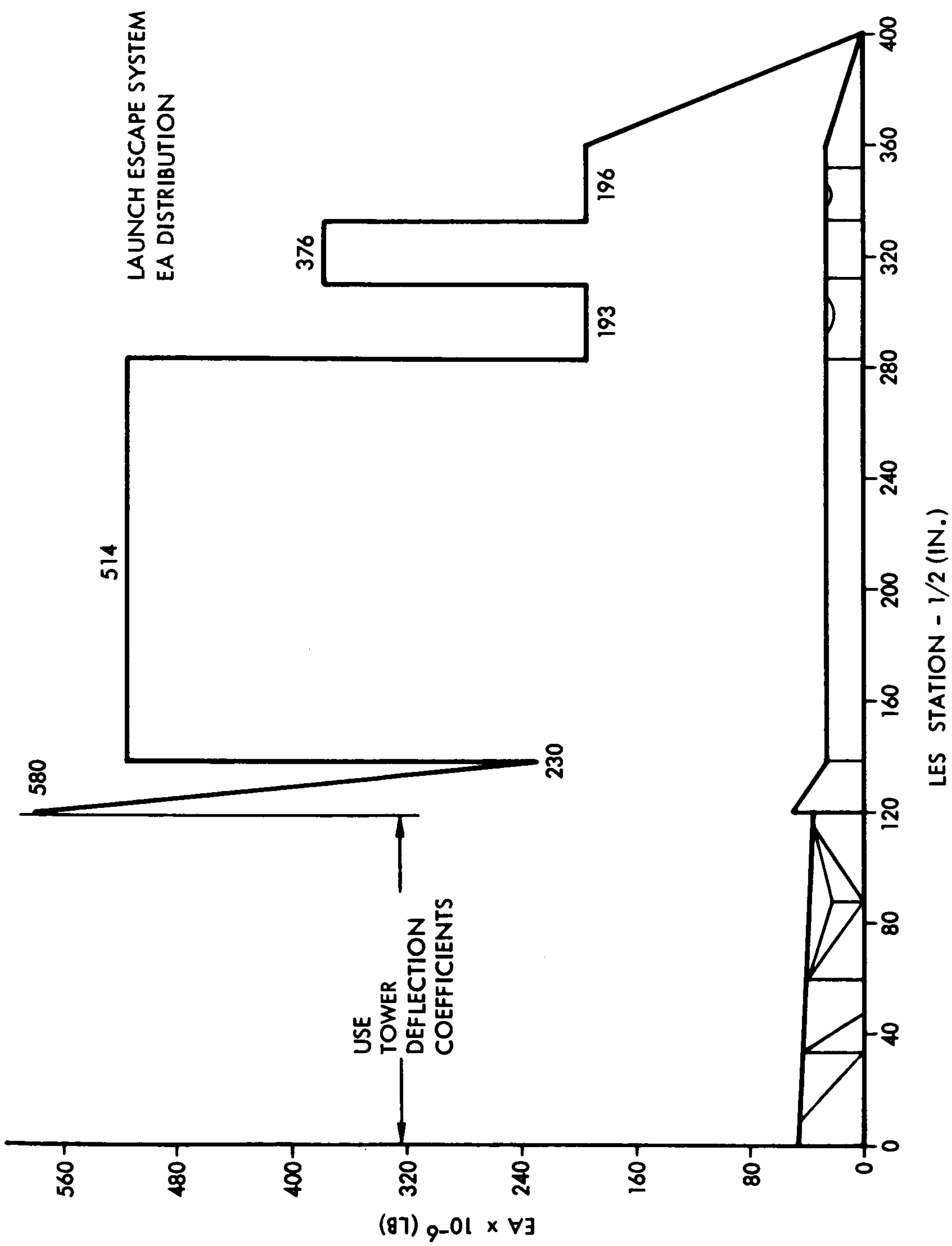


Figure 36. Block I Launch Escape Subsystem Axial Stiffness Distribution

[redacted]

[redacted]

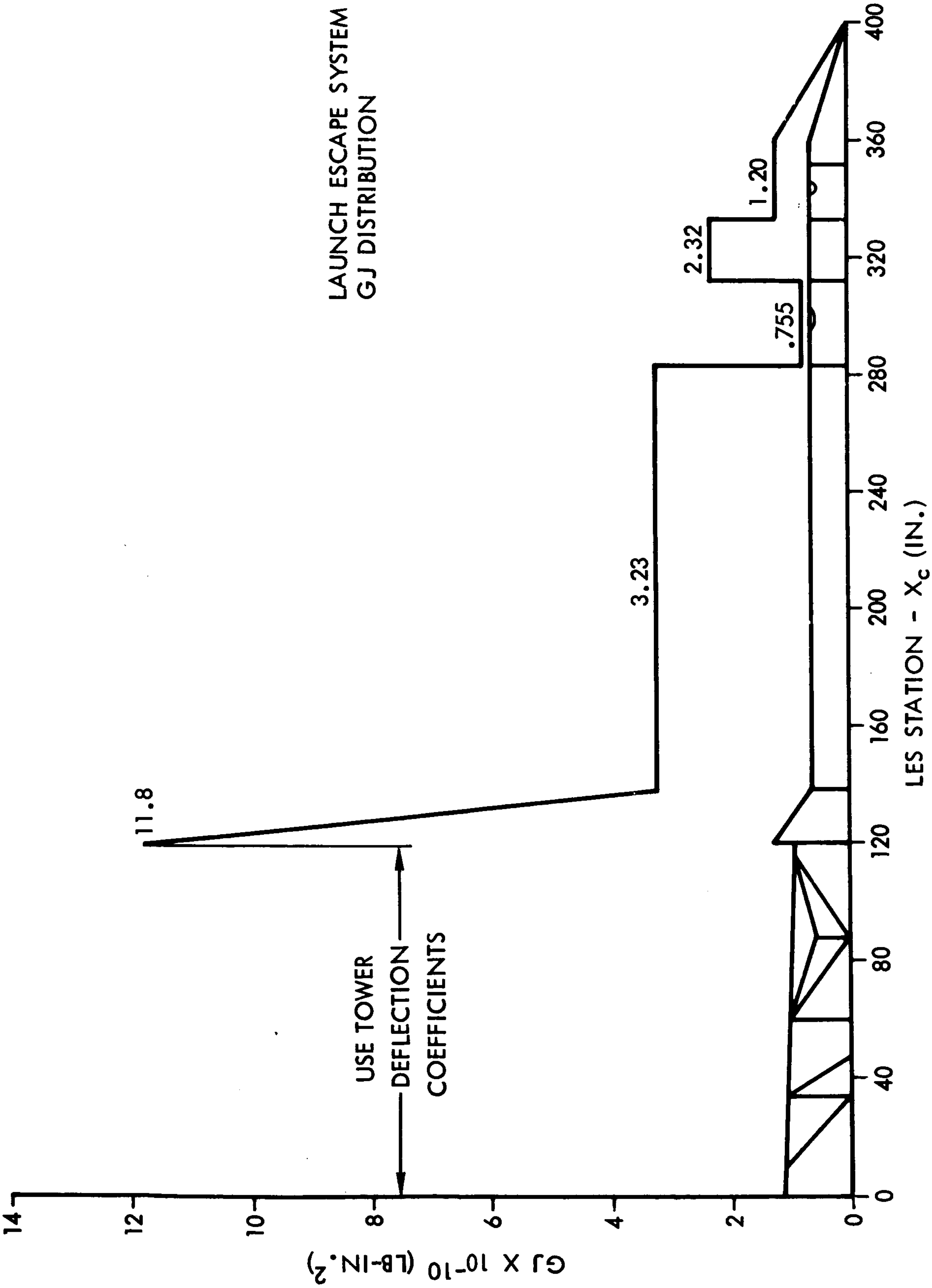
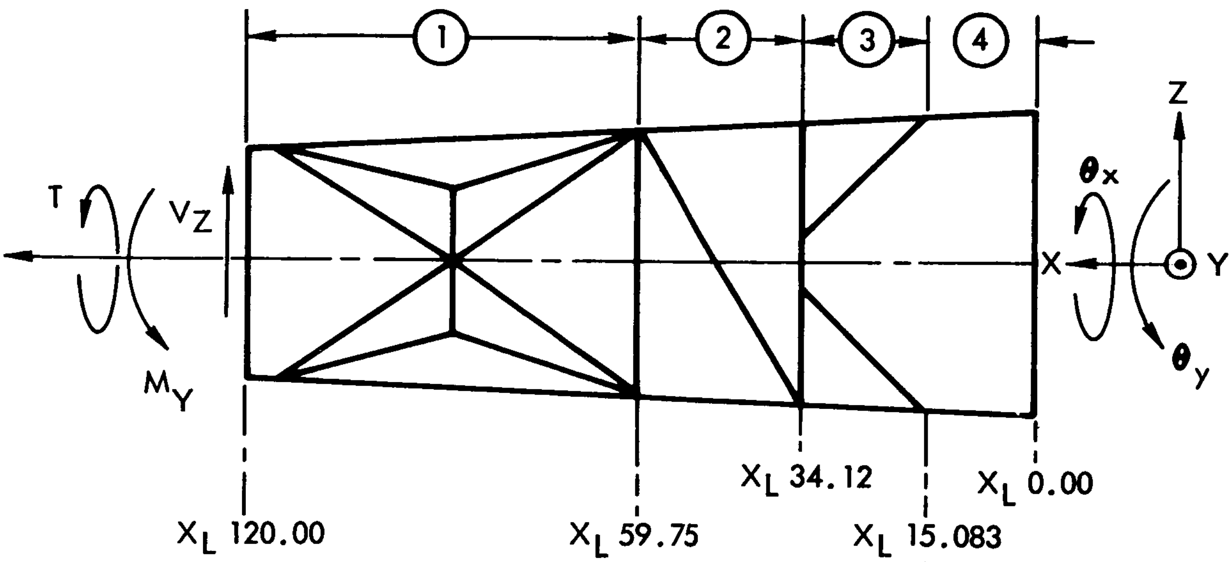


Figure 37. Block I Launch Escape Subsystem Torsional Stiffness Distribution

[redacted]

[redacted]

TOWER CONFIGURATION



LATERAL DEFLECTION COEFFICIENTS

SECTION (1):

$$\begin{Bmatrix} \delta_Z \\ \theta_y \end{Bmatrix} = 10^{-6} \begin{bmatrix} 12.20 & -.0245 \\ -.0247 & .001823 \end{bmatrix} \begin{Bmatrix} V_Z \\ M_Y \end{Bmatrix}$$

SECTION (2):

$$\begin{Bmatrix} \delta_Z \\ \theta_y \end{Bmatrix} = 10^{-6} \begin{bmatrix} 5.04 & .00443 \\ .00364 & .000668 \end{bmatrix} \begin{Bmatrix} V_Z \\ M_Y \end{Bmatrix}$$

SECTION (3):

$$\begin{Bmatrix} \delta_Z \\ \theta_y \end{Bmatrix} = 10^{-6} \begin{bmatrix} 6.28 & .01062 \\ .01840 & .00413 \end{bmatrix} \begin{Bmatrix} V_Z \\ M_Y \end{Bmatrix}$$

SECTION (4):

$$\begin{Bmatrix} \delta_Z \\ \theta_y \end{Bmatrix} = 10^{-6} \begin{bmatrix} 18.10 & .01662 \\ .00975 & .0001792 \end{bmatrix} \begin{Bmatrix} V_Z \\ M_Y \end{Bmatrix}$$

OVERALL:

$$\begin{Bmatrix} \delta_Z \\ \theta_y \end{Bmatrix} = 10^{-6} \begin{bmatrix} 43.3 & -.0875 \\ -.0875 & .00308 \end{bmatrix} \begin{Bmatrix} V_Z \\ M_Y \end{Bmatrix}$$

Figure 38. Block I Launch Escape Subsystem Tower Deflection Coefficients

[redacted]

[redacted]

LAUNCH ESCAPE SYSTEM

TOWER DEFLECTION COEFFICIENTS

Axial Deflection Coefficients

Section (1):	$\delta_x = .602 \text{ P} \times 10^{-6}$
Section (2):	$\delta_x = .289 \text{ P} \times 10^{-6}$
Section (3):	$\delta_x = .1947 \text{ P} \times 10^{-6}$
Section (4):	$\delta_x = .0895 \text{ P} \times 10^{-6}$
Overall:	$\delta_x = 1.175 \text{ P} \times 10^{-6}$

Torsional Deflection Coefficients

Section (1):	$\theta_x = .01621 \text{ T} \times 10^{-6}$
Section (2):	$\theta_x = .00572 \text{ T} \times 10^{-6}$
Section (3):	$\theta_x = .00588 \text{ T} \times 10^{-6}$
Section (4):	$\theta_x = .01603 \text{ T} \times 10^{-6}$
Overall:	$\theta_x = .0438 \text{ T} \times 10^{-6}$

Figure 39. Launch Escape System Tower Deflection Coefficients

[redacted]

[redacted]

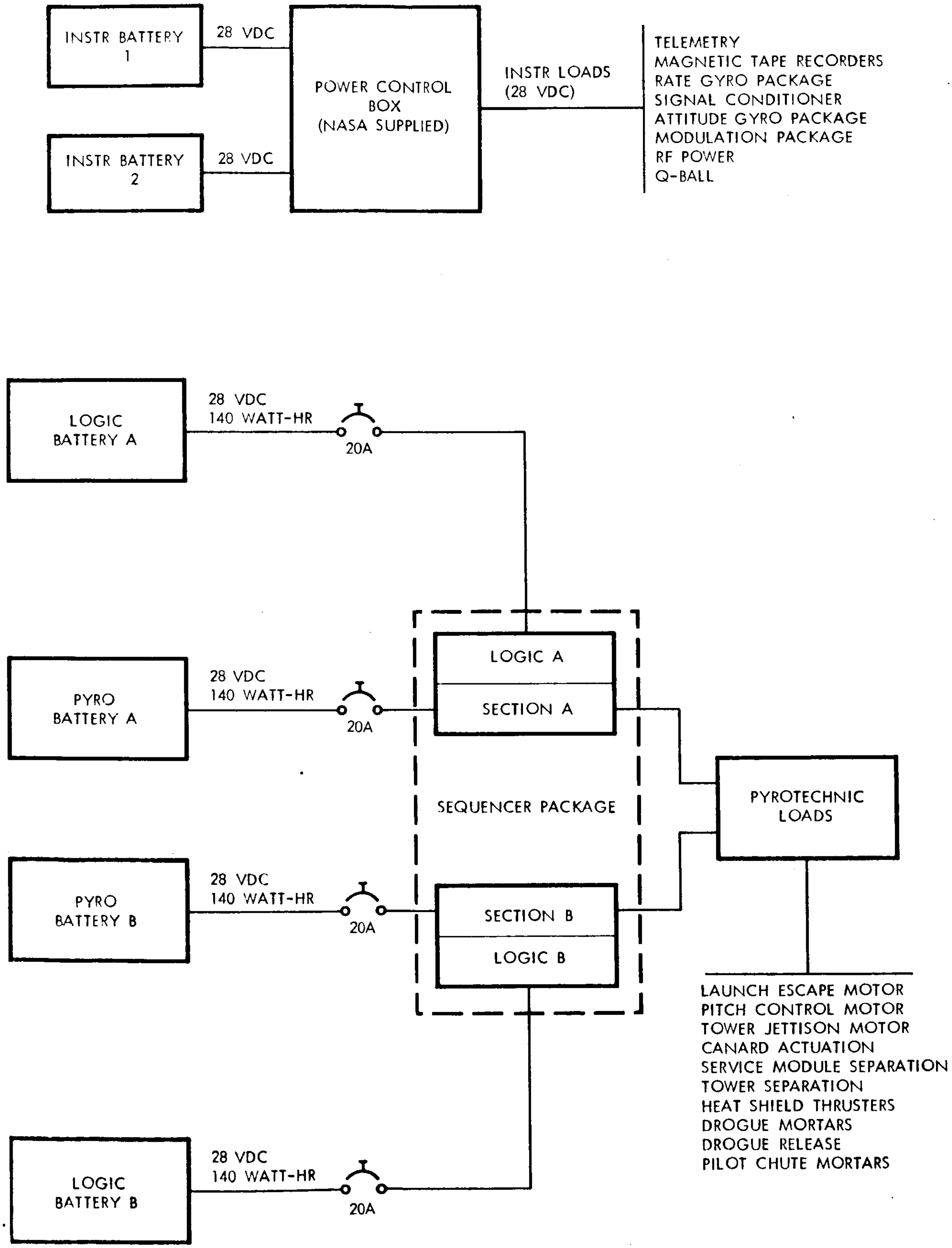


Figure 40. Electrical Power Distribution

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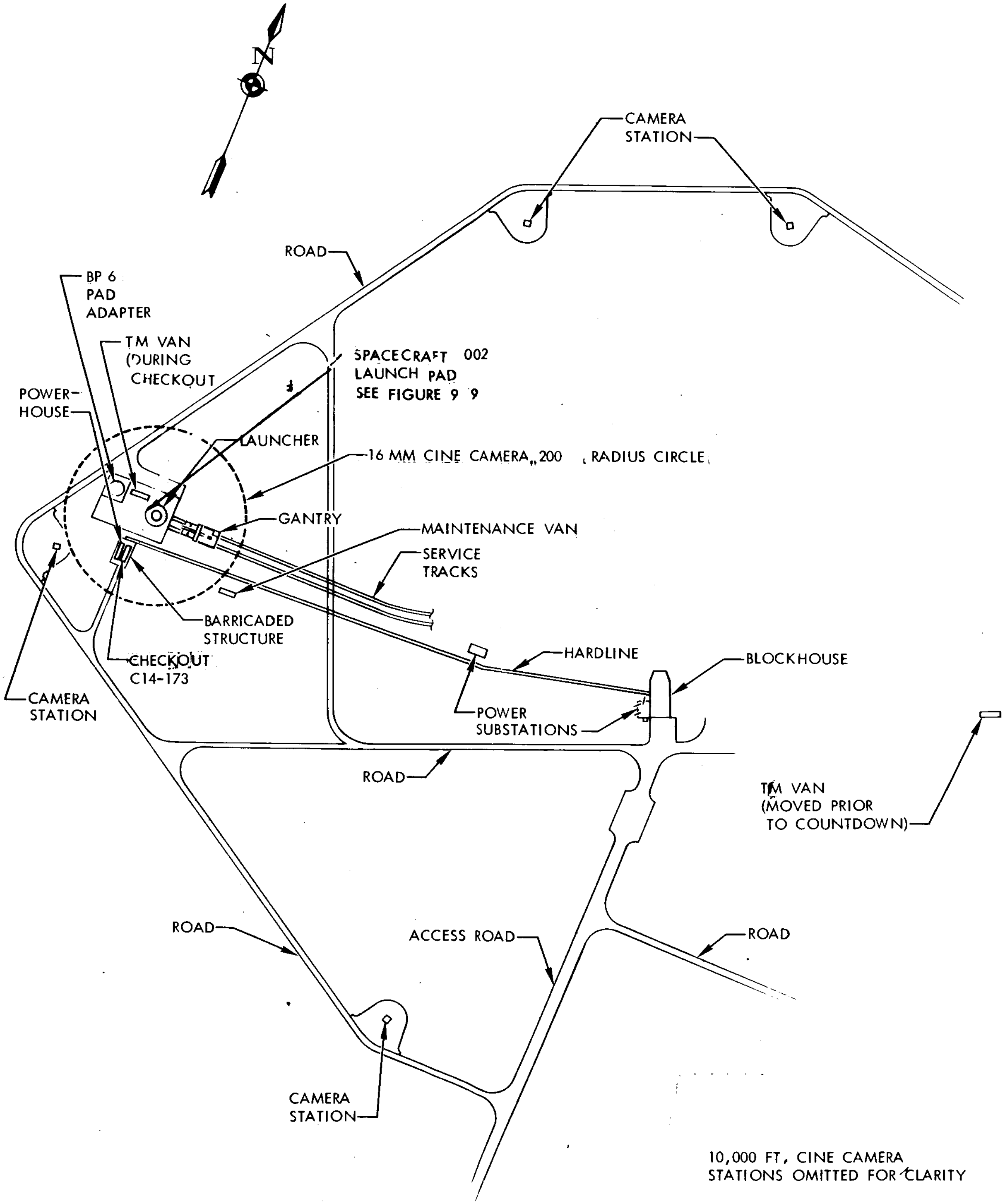


Figure 41. Launch Complex 36, WSMR

[redacted]

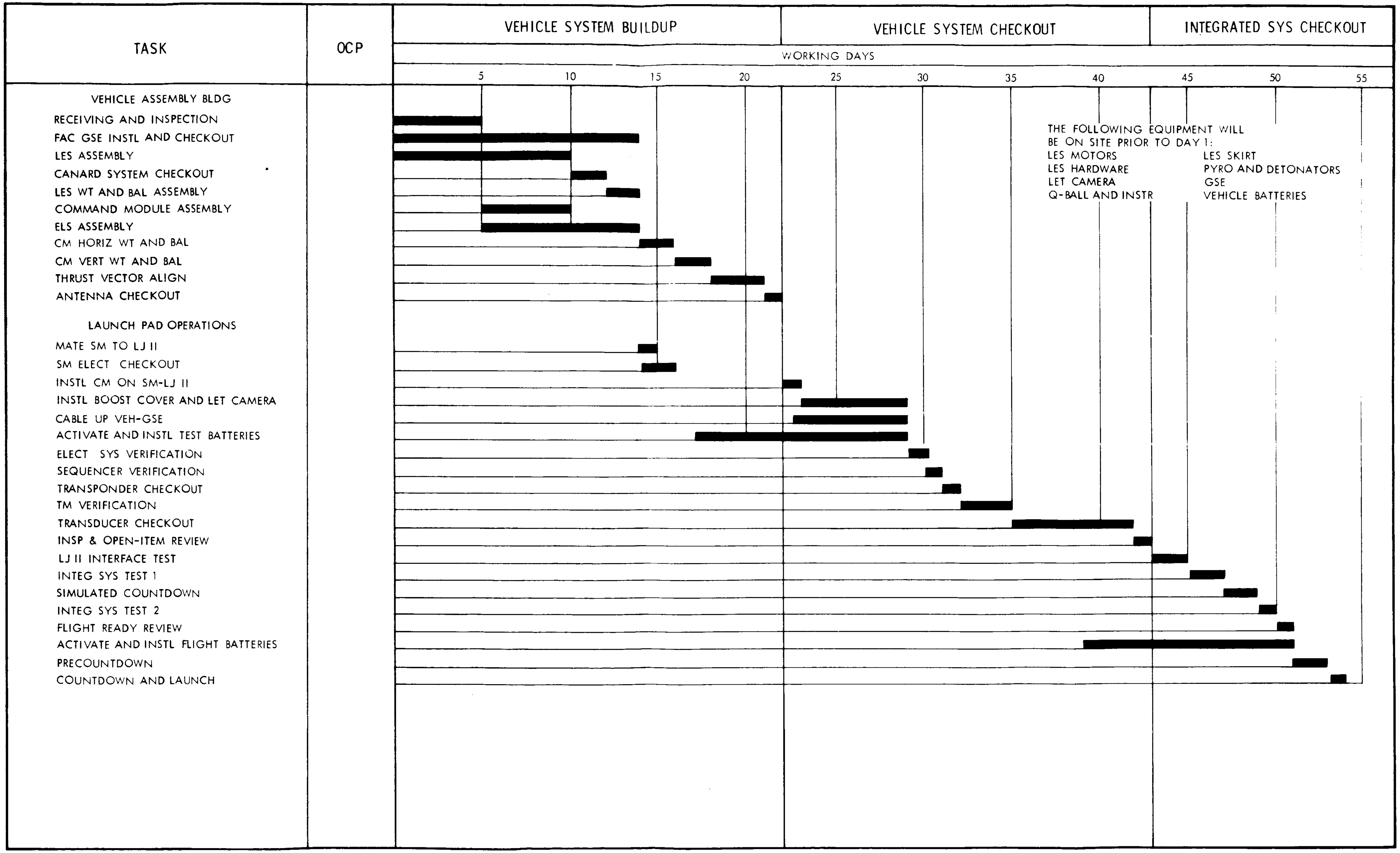
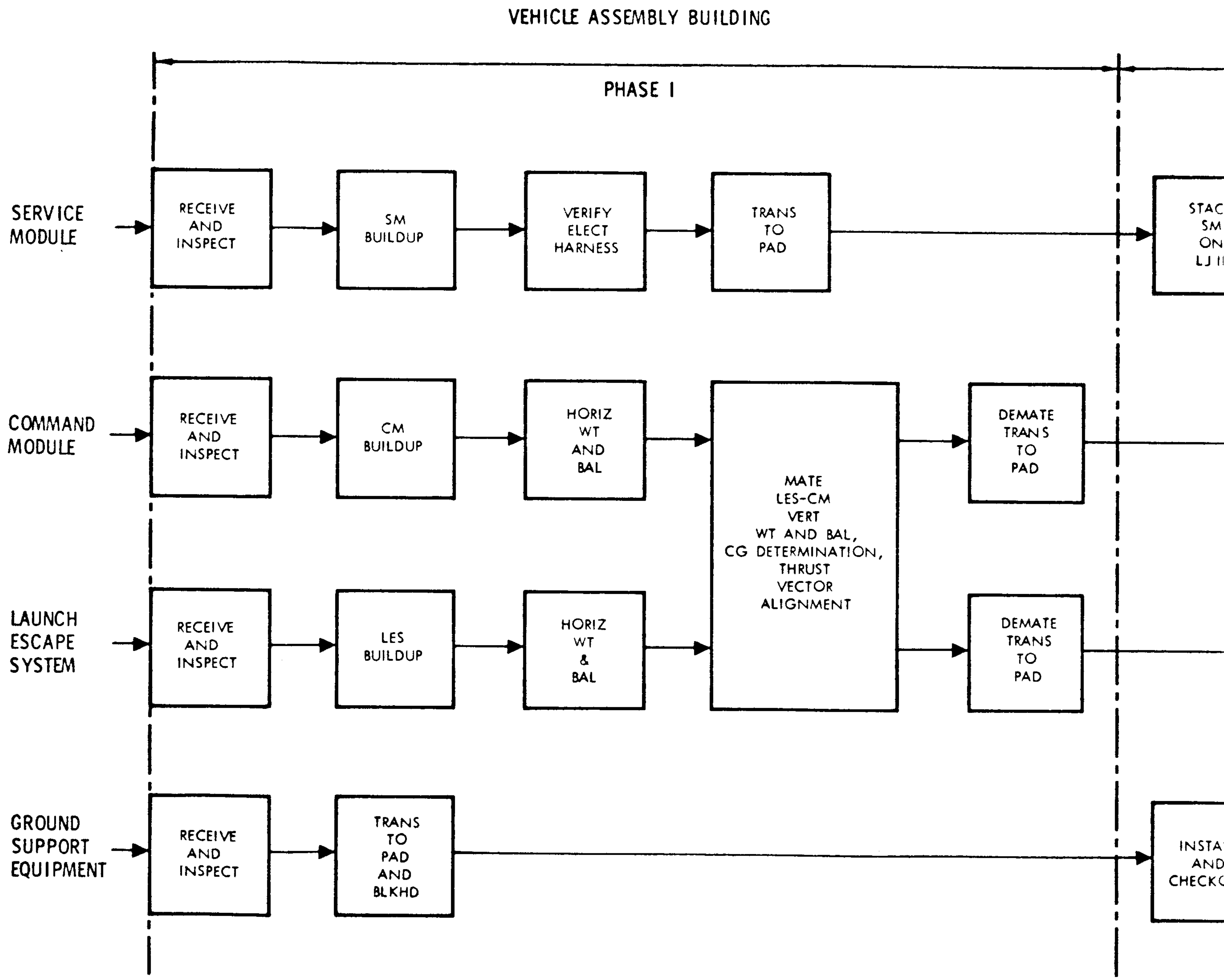


Figure 42. WSMR Operations Schedule

[redacted]


VEHICLE ASSEMBLY BUILDING
PHASE I
SERVICE MODULE
RECEIVE AND INSPECT
SM BUILDUP
VERIFY ELECT HARNESS
TRANS TO PAD
COMMAND MODULE
RECEIVE AND INSPECT
CM BUILDUP
HORIZ WT AND BAL
MATE LES-CM VERT WT AND BAL, CG DETERMINATION, THRUST VECTOR ALIGNMENT
DEMATE TRANS TO PAD
LAUNCH ESCAPE SYSTEM
RECEIVE AND INSPECT
LES BUILDUP
HORIZ WT & BAL
DEMATE TRANS TO PAD
GROUND SUPPORT EQUIPMENT
RECEIVE AND INSPECT
TRANS TO PAD AND BLKHD

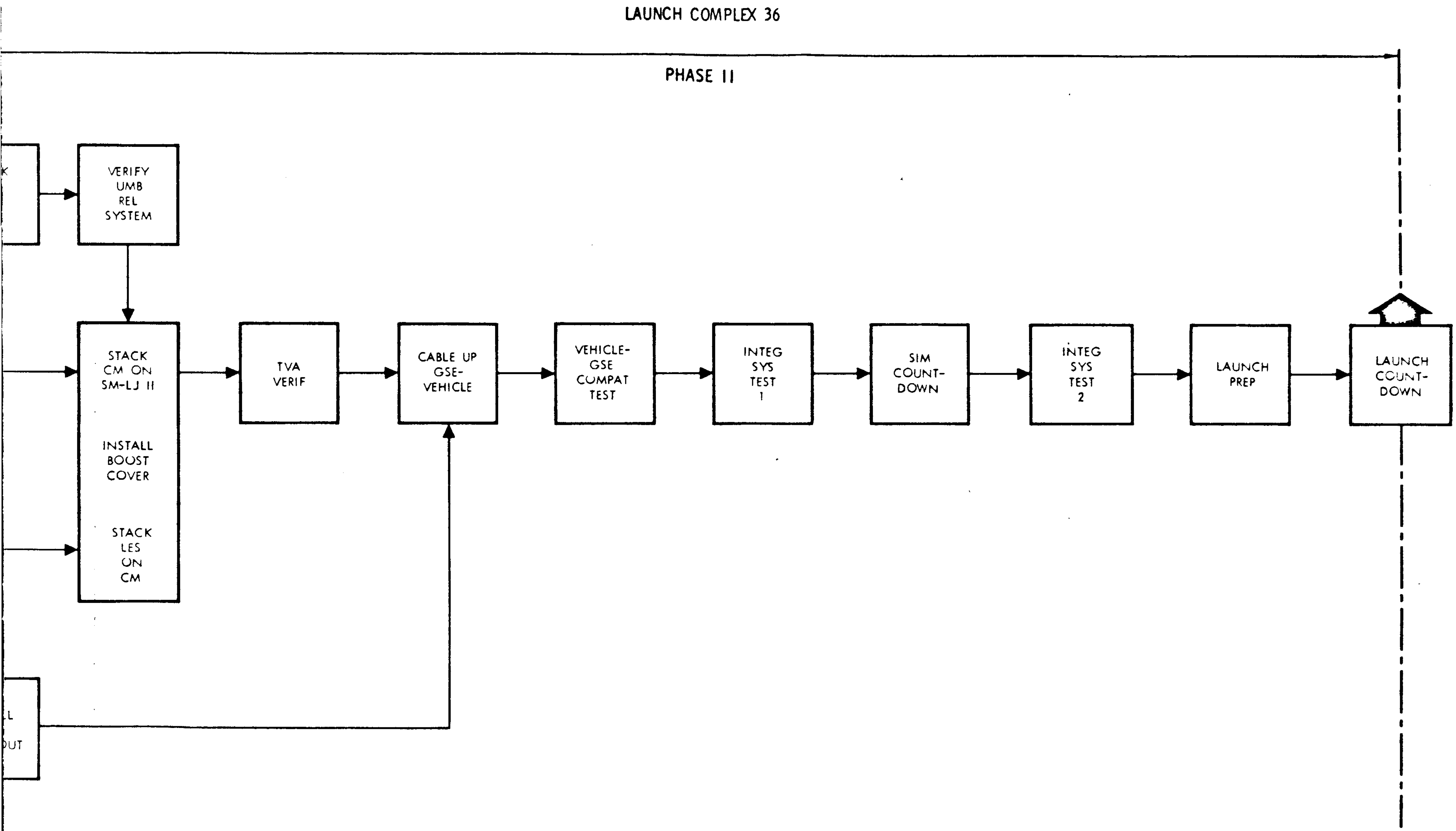


Figure 43. Prelaunch Operational Flow, WSMR

[redacted]

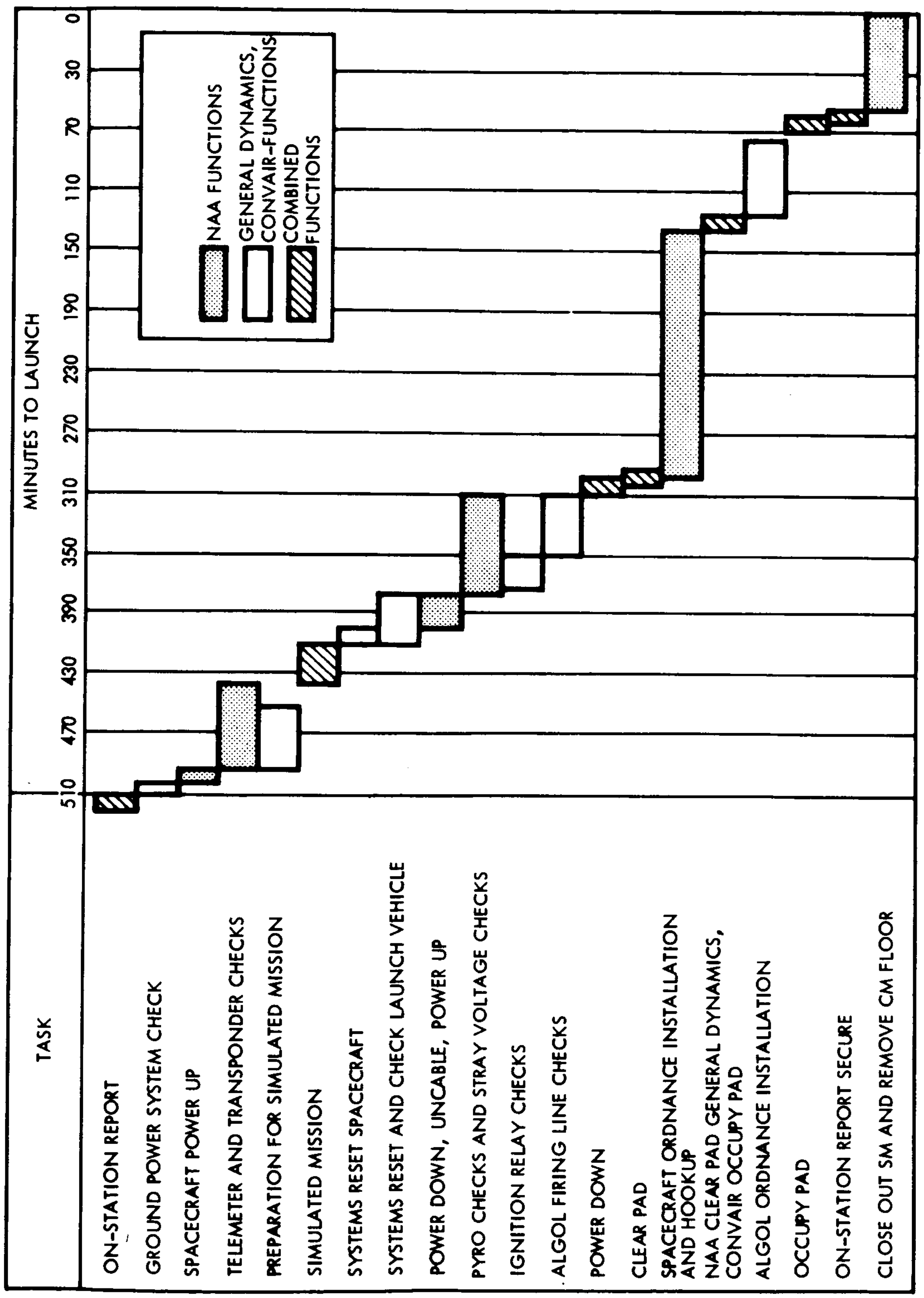


Figure 44. Precountdown Task Sequence

[redacted]

[redacted]

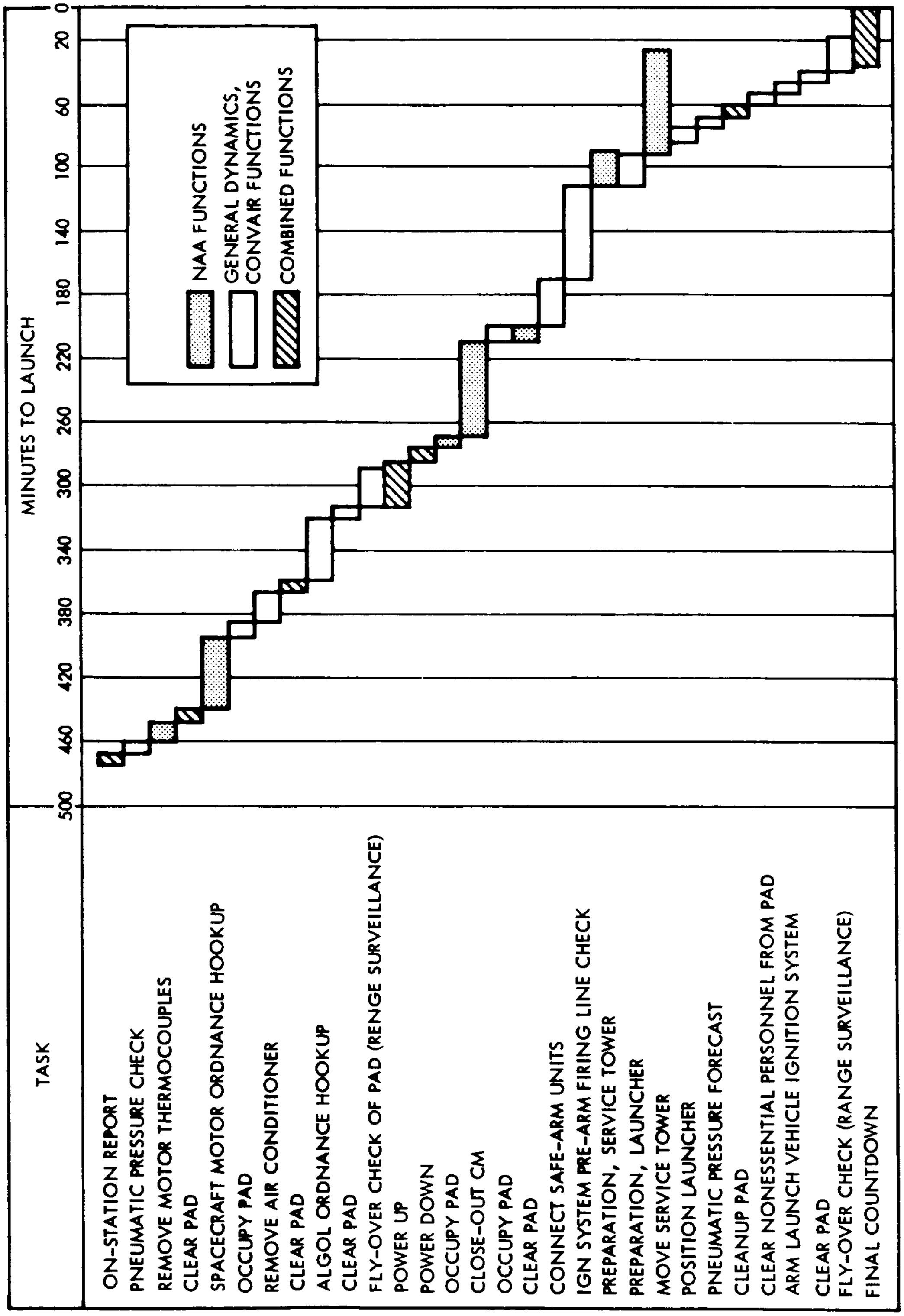


Figure 45. Countdown Task Sequence

[redacted]

[redacted]

Table I. Nominal Sequence of Mission Events (Preliminary)

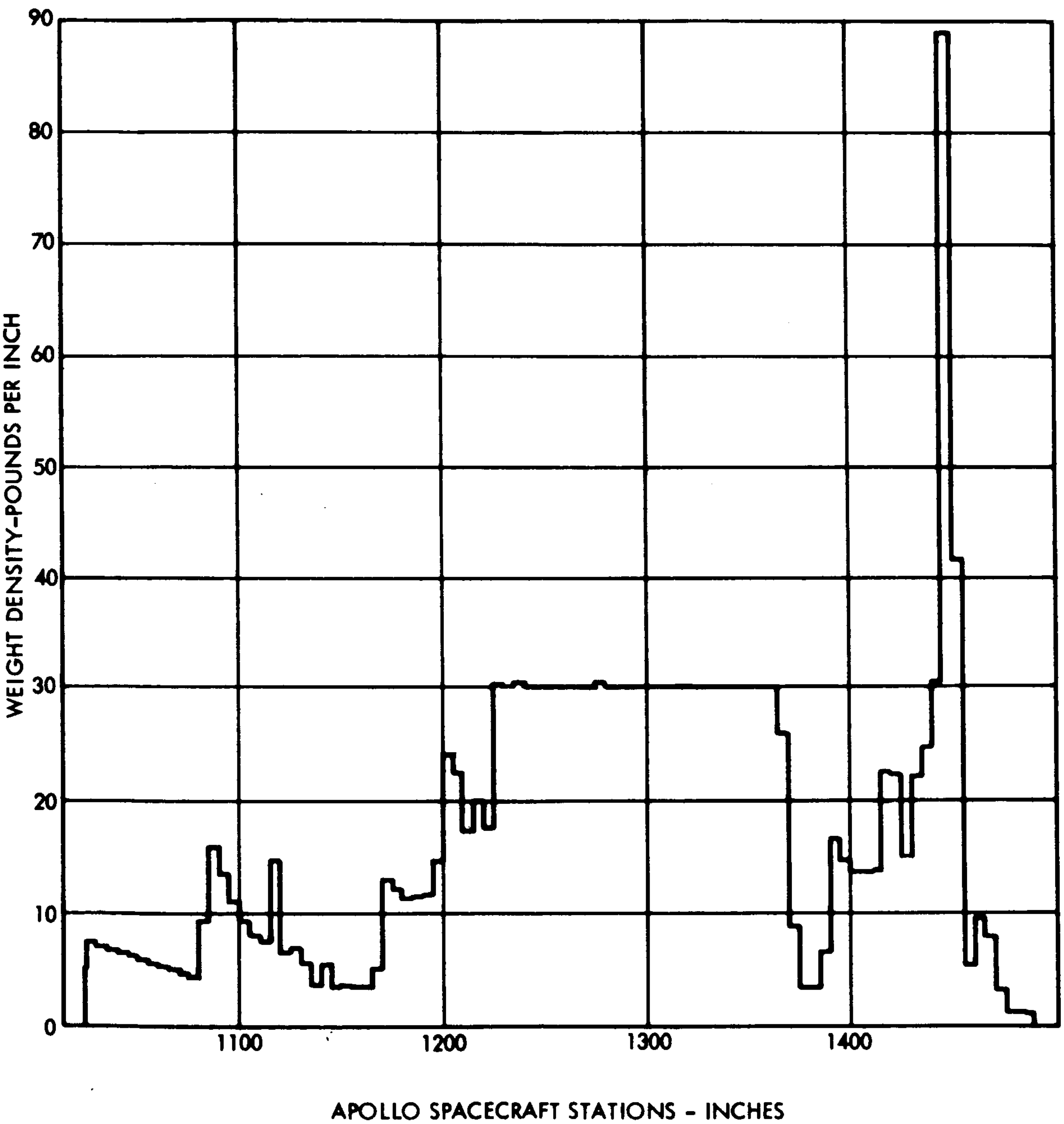
Time (sec)	Event	Mach No.	Dynamic Pressure (psf)	Altitude (ft)
T -	Little Joe II ignition (2 Algol engines)	0	0	4,036
T + 0	Test vehicle lift-off		0	4,036
T + 37	Ignition of third and fourth Algols (Little Joe II)	1.0	630.0	20,000
T + 75.7	Test vehicle pitch-up initiation	2.42	547.0	62,500
T + 78	Abort initiation	2.42	547.0	62,500
T + 85.1	Backup abort initiation*			
T + 89.5	Canard deployment	1.54	144.0	72,560
T + 102.0	Apogee			75,500
T + 146.0	Termination of tumbling			51,000
T + 187.7	LES plus BPC jettison	0.51	156.0	
T + 229.0	Disreef (main chutes)*			
T + 413.0	Command module touchdown	0.2	9.0	4,036

*Information will be available at a later date.

[redacted]

[redacted]

TABLE II. LAUNCH ESCAPE SUBSYSTEM MASS DISTRIBUTION



[redacted]

[redacted]

TABLE III. COMMAND MODULE MASS DISTRIBUTION

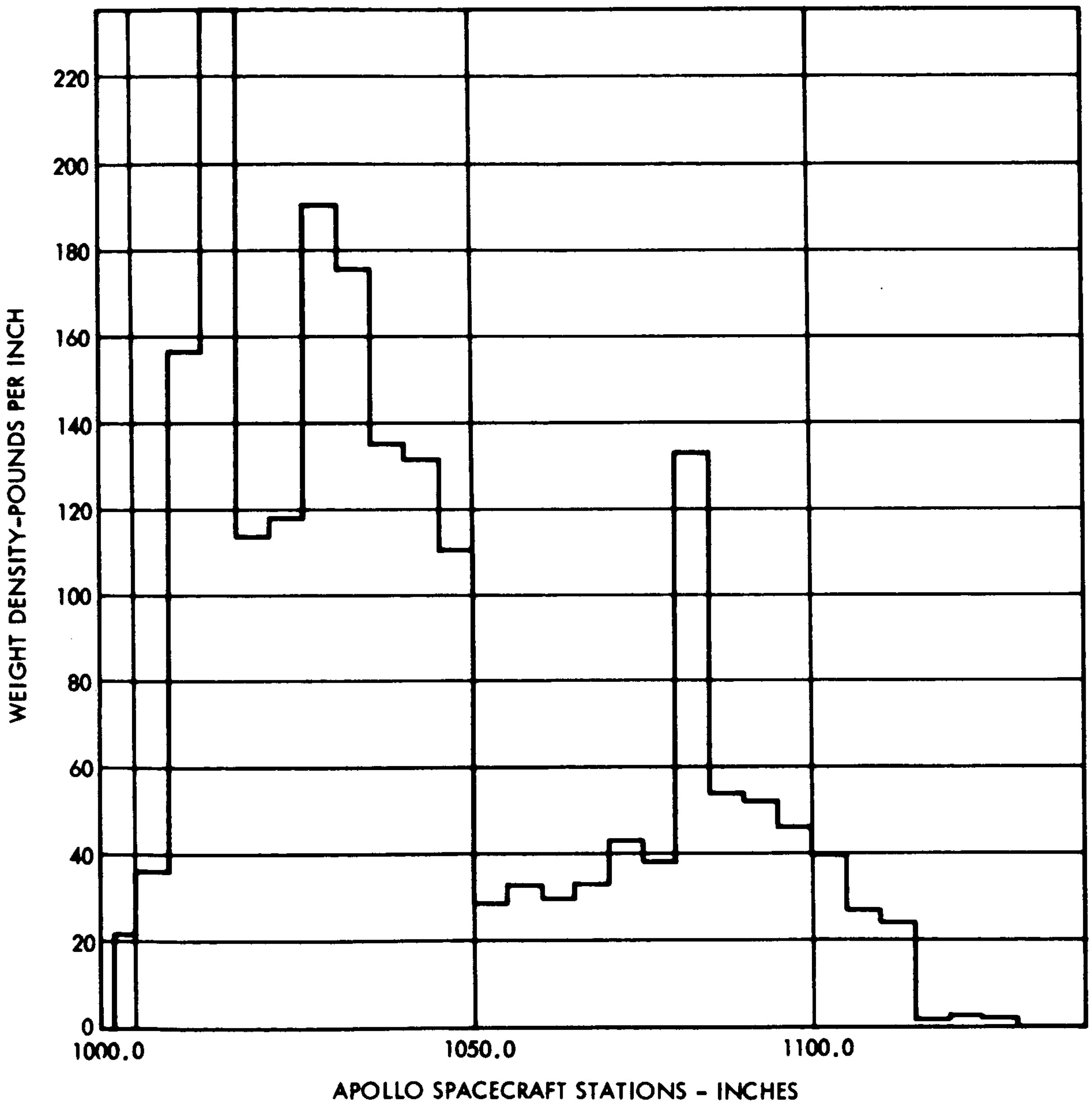


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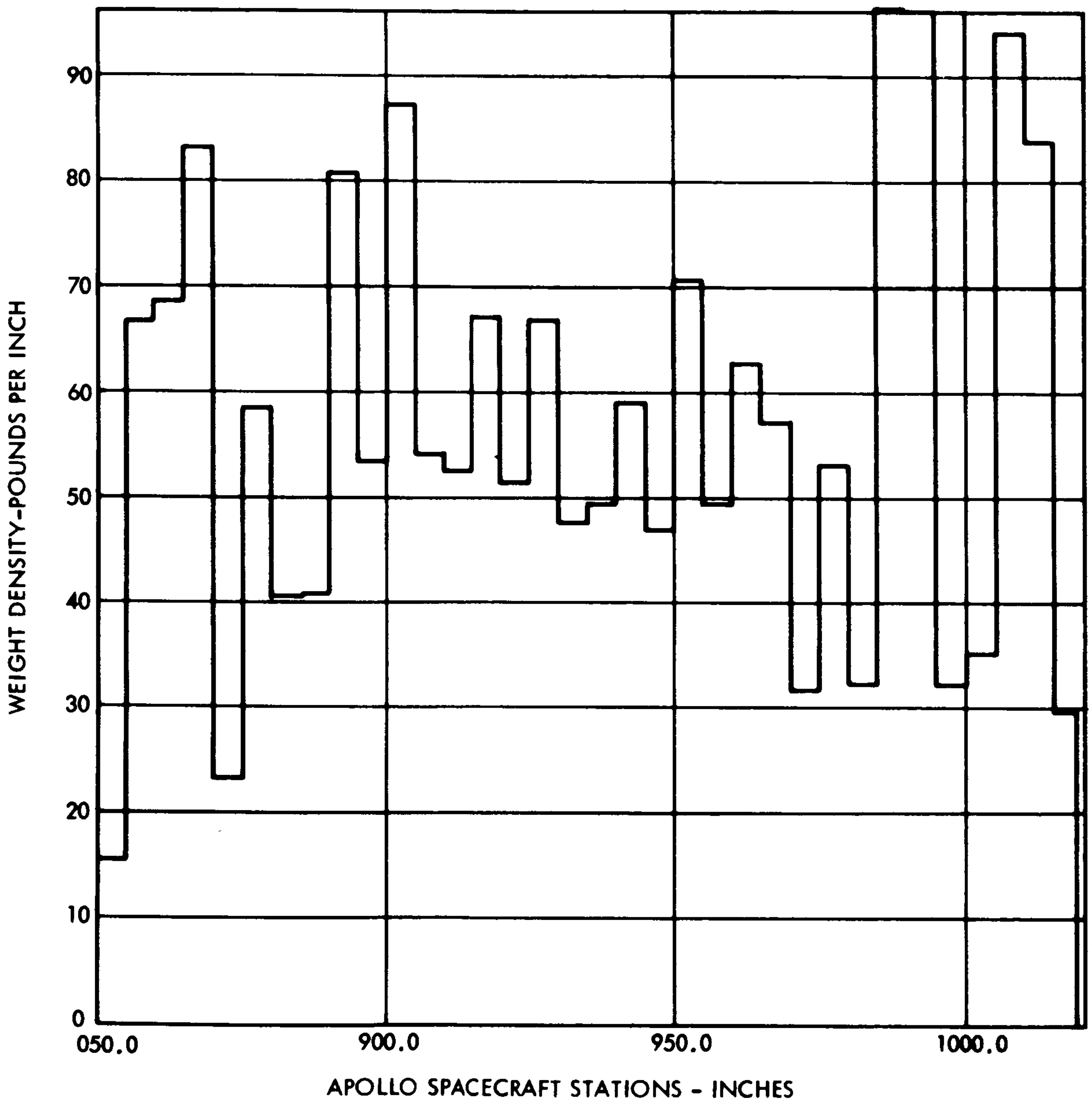
TABLE IV. SERVICE MODULE MASS DISTRIBUTION



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